Bureau of Air Quality

South Carolina Department of Health and Environmental Control

State of South Carolina: 5-Year Ambient Air Monitoring Network Assessment

July 1, 2015

List of Appendices

Introduction

On October 17, 2006, the EPA promulgated final ambient air monitoring regulations. As part of this final rule, the EPA required states to conduct periodic assessments of their ambient air monitoring networks.

> *"The State, or where applicable local, agency shall perform and submit to the EPA Regional Administrator an assessment of the air quality surveillance system every 5 years to determine, at a minimum, if the network meets the monitoring objectives defined in appendix D to this part, whether new sites are needed, whether existing sites are no longer needed and can be terminated, and whether new technologies are appropriate for incorporation into the ambient air monitoring network. The network assessment must consider the ability of existing and proposed sites to support air quality characterization for areas with relatively high populations of susceptible individuals (e.g., children with asthma), and, for any sites that are being proposed for discontinuance, the effect on data users other than the agency itself, such as nearby States and Tribes or health effects studies. For $PM_{2.5}$, the assessment also must identify needed changes to population-oriented sites. The State, or where applicable local, agency must submit a copy of this 5-year assessment, along with a revised annual network plan, to the Regional Administrator. The first assessment is due July 1, 2010."*

At a minimum, the five-year air quality monitoring network assessment is required to determine:

1. If the network meets the monitoring objectives defined in Appendix D to 40 CFR Part 58[1],
2. Whether new monitoring sites are needed[1],
3. Whether existing sites are no longer needed and can be terminated[1],
4. Whether new technologies are appropriate for incorporation into the air monitoring network[1],
5. Whether the network sufficiently supports characterization of air quality in areas with large populations of susceptible individuals[1],
6. Whether discontinuance of a monitoring site would have an adverse impact on other data users or health studies[1],
7. For $PM_{2.5}$, the assessment must identify needed changes to population oriented sites[1],
8. If monitoring is required near any additional Pb sources according to the most recent National Emissions Inventory[2],

[1] 40 CFR Part 58.10(d)
[2] 40 CFR 58 Appendix D, Section 4.5

9. Any waiver of 40 CFR Parts 50 and/or 58 regulatory requirements must be renewed during each 5-Year Assessment unless otherwise specified to be renewed annually during the network plan process[2],
    a. Pb source monitoring waivers[2],
    b. Continuous PM2.5 FEM Comparability (NAAQS Exclusion)[3],
    c. Siting criteria[4], and
    d. Any additional waiver of Part 50 and/or 58 regulatory requirements.

Additionally, EPA Region 4 requires that states consider the following information when developing their network assessments:

1. Statewide and local level population statistics,
2. Statewide ambient air monitoring network pollutant concentration trends for the past five years,
3. Network suitability to measure the appropriate spatial scale of representativeness for selected pollutants,
4. Monitoring data spatial redundancy or gaps that need to be eliminated, and
5. Programmatic trends or shifts in emphasis or funding that lead toward different data needs.

The most recent Ambient Air Monitoring Network Guidance was issued by EPA in February, 2007 and details a series of analyses that could be used to conduct an ambient air monitoring network assessment[5]. According to this guidance document, a network assessment "includes (1) re-evaluation of the objectives and budget for air monitoring, (2) evaluation of a network's effectiveness and efficiency relative to its objectives and costs, and (3) development of recommendations for network reconfigurations and improvements."

As specified in this guidance, a network assessment consists of six steps detailed in the table below. This document will utilize these steps in the technical assessment of South Carolina's ambient air monitoring network.

Steps to Conduct an Ambient Air Monitoring Network Assessment		
Step	**Description**	**Examples**
1	Prepare or update a regional description, discussing important features that should be considered for network design.	Topography, climate, population, demographic trends, major emissions sources, and current air quality conditions

[3] 40 CFR 58.11(e)
[4] 40 CFR Part 58 Appendix E, Section 10
[5] Ambient Air Monitoring Network Assessment Guidance: Analytical Techniques for Technical Assessments of Ambient Air Monitoring Networks (http://www.epa.gov/ttn/amtic/files/ambient/pm25/datamang/network-assessment-guidance.pdf)

Steps to Conduct an Ambient Air Monitoring Network Assessment		
2	Prepare or update a network history that explains the development of the air monitoring network over time and the motivations for network alterations, such as shifting needs or resources.	Historical network specifications (e.g., number and locations of monitors by pollutant and by year in graphical or tabular format); history of individual monitoring sites
3	Perform statistical analyses of available monitoring data. These analyses can be used to identify potential redundancies or to determine the adequacy of existing monitoring sites.	Site correlations, comparisons to the National Ambient Air Quality Standards (NAAQS), trend analysis, spatial analysis, and factor analysis
4	Perform situational analyses, which may be objective or subjective. These analyses consider the network and individual sites in more detail, taking into account research, policy, and resource needs.	Risk of future NAAQS exceedances, demographic shifts, requirements of existing state implementation plans (SIP), or maintenance plans, density or sparseness of existing networks, scientific research or public health needs, and other circumstances (such as political factors)
5	Suggest changes to the monitoring network on the basis of statistical and situational analyses and specifically targeted to the prioritized objectives and budget of the air monitoring program.	Reduction of number of sites for a selected pollutant, enhanced leveraging with other networks, and addition of new measurements at sites to enhance usefulness of data
6	Acquire the input of state and local agencies or stakeholders and revise recommendations as appropriate.	

Limitations of the 5-Year Network Assessment Tools

Although the Department understands the value of the 5-year monitoring network assessment, the tools that the EPA have made available to conduct this assessment are limited in their ability to adequately assess all of the monitoring networks. The scoring and ranking of the monitors, as suggested by the EPA guidance, are not suited to small communities with neighborhood and urban scale monitors, but are more appropriate for large regional and national scale assessments. The Department believes that the results from using the EPA's tools have only provided a rough indicator of possible areas that may need adjustment. To create a true picture of actual needed monitoring changes, other factors, such as knowledge of communities, local monitoring history, emissions and population shifts and demographics must be considered and utilized. These are factors that the State is in the best position to judge, and the EPA should defer to the State's knowledge in crafting a monitoring network to represent ambient exposures to these pollutants.

For example, using the EPA's suggested methodology, the Sandhill Monitoring Site is assigned a "Low" value and should be considered for termination, yet this Site is in a very rapidly growing area of Columbia, downwind of the metropolitan area. Another example is the Jackson Middle School Monitoring Site in southwestern Aiken County. This Site monitors Ozone concentrations upwind of the Augusta urbanized area, and is a valuable site to measure ozone transport, yet it was also ranked "Low". In both cases using the EPA's suggested methodology as instructed failed to rank the monitors appropriately. Therefore, the Department believes that the results of this 5-Year Network Assessment should be considered very rudimentary and must be supplemented with local knowledge and context in order to create an accurate 5-Year Network Assessment. Also, EPA should use its expertise to develop and refine a more inclusive toolbox for state scaled monitoring networks before the next 2020 deadline that would result in appropriate and efficient monitoring networks.

Document background

This document contains a technical description of the South Carolina Department of Health and Environmental Control (Department) ambient air monitoring network as of January 1, 2015, and analysis based on data for the years 2009 – 2013. At the time the assessment was conducted, the 2014 data had not been certified. This assessment evaluates the networks for all criteria pollutants monitored by the Department. Non-criteria sampling was not required to be assessed as part of this review. Because the design of the technical tools provided by the EPA for assessing monitoring networks is applicable to higher density and spatially distributed networks, a more in-depth review of Ozone and Particulate Matter 2.5 ($PM_{2.5}$) Federal Reference Method (FRM) ambient monitoring has been conducted. The available statistical and spatial tools depend on large monitoring networks that are widely distributed over larger geographic areas. Therefore, only the monitoring networks with sufficient numbers of well distributed monitors, Ozone and $PM_{2.5}$ FRM, were assessed with the full array of tools. The remaining criteria pollutant networks do not have sufficient size and distribution for appropriate application of the tools provided by the EPA. The state networks for these monitors were evaluated based on the requirements specified by 40 CFR 58.10 (d) and associated guidance and were assessed on their perceived value to the Air Quality Program. Appendix B to this document provides the assessment rating and recommendations for optimizing the ambient air monitoring network.

In the summer of 2015, EPA performed a Technical Systems Audit on the South Carolina Monitoring Network. Due to the results of this audit, the South Carolina Monitoring Network was reassessed and some monitoring changes were made. Some of those changes are reflected in this report.

Special project monitoring

In addition to conducting monitoring to meet minimum requirements (Appendix D to 40 CFR Part 58), the Department operates special project monitoring in various areas across the state to investigate and answer specific questions posed by the public, and data needs for the Department. All special project monitoring is done in accordance with the Department's Quality Management Plan[6] (May 2014). Typically, these projects are defined by being short-term monitoring focused on specific interests or concerns. This monitoring is typically driven by local issues and allows the Department to answer specific questions for the local area. For example, in 2010, the Department conducted monitoring in an area where local citizens had concerns about the operation of asphalt plants near their neighborhood. In addition to evaluating the cumulative impacts of the operation of asphalt plants in the neighborhood, the project also gave insight into potential impacts of asphalt plants statewide.

South Carolina's commitment to additional ambient air monitoring is evident in its efforts with special project monitoring. Monitoring is often done in areas with sensitive subpopulations that may be identified as Environmental Justice (EJ) communities. Environmental Justice has been defined as the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies.

In the Charleston/North Charleston area, the Lowcountry Alliance for Model Communities (LAMC) is a nonprofit organization founded for the purpose of advocating environmental justice and promoting community development, education, employment, quality housing, and community involvement for neighborhoods in this area. The neighborhoods represented include the North Charleston neighborhoods of Accabee, Chicora/Cherokee, Union Heights, Howard Heights, Windsor Place, Five Mile, and Liberty Hill. In 2009, this group was awarded EPA's Environmental Justice Achievement Award for their work in conjunction with the city of North Charleston and the South Carolina State Ports Authority to reduce $PM_{2.5}$ emissions. The Department conducted monitoring in this area in order to assess the spatial distribution of $PM_{2.5}$ ambient concentrations and continues to partner with LAMC and other groups in the area on these and other monitoring activities. In addition to the $PM_{2.5}$ monitoring, the Department successfully petitioned the EPA to select Chicora Elementary School to be included in their national study to monitor concentrations of toxic air pollutants near schools.

In Greenville, the Department partnered with community members, city and county officials, and local businesses/organizations to reach consensus on the selection of a more representative location for a new ambient air monitoring site to represent the ambient air quality in the city of Greenville. In 2008, the Department staff held an "Air Fair" to inform and answer questions from local residents about the monitor and what it means for their community, and worked with community leaders on environmental concerns in the area.

[6] The Department's latest Quality Management Plan can be found at: http://www.scdhec.gov/HomeAndEnvironment/Docs/QMPJuly2008.pdf

Minimum monitoring requirements

The EPA has established minimum ambient air monitoring requirements for each of the criteria pollutants (Ozone, $PM_{2.5}$, PM_{10}, Lead, SO_2, NO_2 and CO). The table below lists the minimum ambient air monitoring requirements for each Metropolitan Statistical Area (MSA) followed by the current number of sites where the indicated parameter is measured.

South Carolina currently meets or exceeds minimum ambient air monitoring requirements for all criteria pollutants.

2015 Minimum Ambient Air Monitoring Requirements by MSA for Each Criteria Pollutant								
MSA	Ozone	$PM_{2.5}$	$PM_{2.5}$ Continuous	PM_{10}	Lead	SO_2	NO_2	CO
Augusta-Richmond County (SC) ‡	2 (2)	1 (1)	1 (1)	1-2 (0)	0 (0)	1 (0)	0	0
Charleston-North Charleston	1 (2)	1 (3)	1 (2)	1-2 (1)	0	1 (2)	0 (2)	0
Charlotte-Gastonia-Concord (SC) ‡	2 (1)	2 (0)	1 (0)	2-4 (0)	0	1 (1)	2	1
Columbia	2 (3)	1 (3)	1 (2)	1-2 (2)	0 (1)	1 (3)	1 (1)	1 (1)
Florence	1 (1)	0 (1)	0 (1)	0	0 (3)	0	0	0
Greenville-Anderson-Mauldin	2 (3)	1 (3)	1 (1)	1-2 (1)	0	1 (1)	1 (1)	0
Hilton-Head Island-Bluffton-Beaufort	0	0	0	0	0	0	0	0
Myrtle Beach-Conway-North Myrtle Beach (SC)	1 (1)	0	0	0-1	0	0	0	0
Spartanburg	1 (1)	0 (1)	0 (1)	0-1 (0)	0	0	0	0
Sumter	0	0	0	0	0	0	0	0
Rest of State	0 (3)	0 (1)	0 (3)	0 (3)	0	0	0	0
Notes: Numbers in parentheses indicate the number of current Department monitors for the given parameter. Blank cells indicate parameters with no minimum ambient air monitoring requirements and no ambient air monitoring currently conducted. ‡ Minimum ambient air monitoring requirements are met through cooperation with the State of Georgia and State of North Carolina. Only current ambient air monitoring/sampling contained within the South Carolina portion of the MSA is listed in this table.								

GIS Methodology for Conducting a Network Assessment

A series of parameters described in steps 2 and 3 of this document were scored to rank individual ambient air monitoring sites. As described earlier, this analysis will focus on the

Ozone and $PM_{2.5}$ FRM networks. A limitation of the technique described in the next section is it depends on large, spatially uniform monitoring networks. The Department has concerns about utilizing this methodology, but with the lack of other viable options, this was determined to be the best tool available.

Thiessen (Voronoi) polygons were created to divide the state into “areas of representation” and allocate each polygon to the nearest monitor. For this assessment, Thiessen polygons did not extend beyond the state boundary to capture ambient air monitoring sites in other states. Each polygon consists of the points closer to one particular site than any other site. The data for the emissions and population categories were aggregated by Thiessen polygons. Monitoring sites were scored based on these aggregated values. The Department chose this technique for scoring because it was the best available tool to objectively assign values to an individual ambient air monitoring site.

There are many limitations with using Thiessen polygons. These polygons are not a true indication of which site is the most representative of the pollutant concentration in a given area. Meteorology (including pollutant transport), topography, and proximity to population or emission sources are not considered. Therefore, some areas assigned to a particular monitor may actually be better represented by a different monitor. Thiessen polygons tend to give more weight to rural sites and those sites on the edges of urban areas or other monitor clusters. The Department continues to search for additional techniques for assigning “areas of representation” and welcomes input from the EPA on improved methods for determining this metric to improve future assessments.

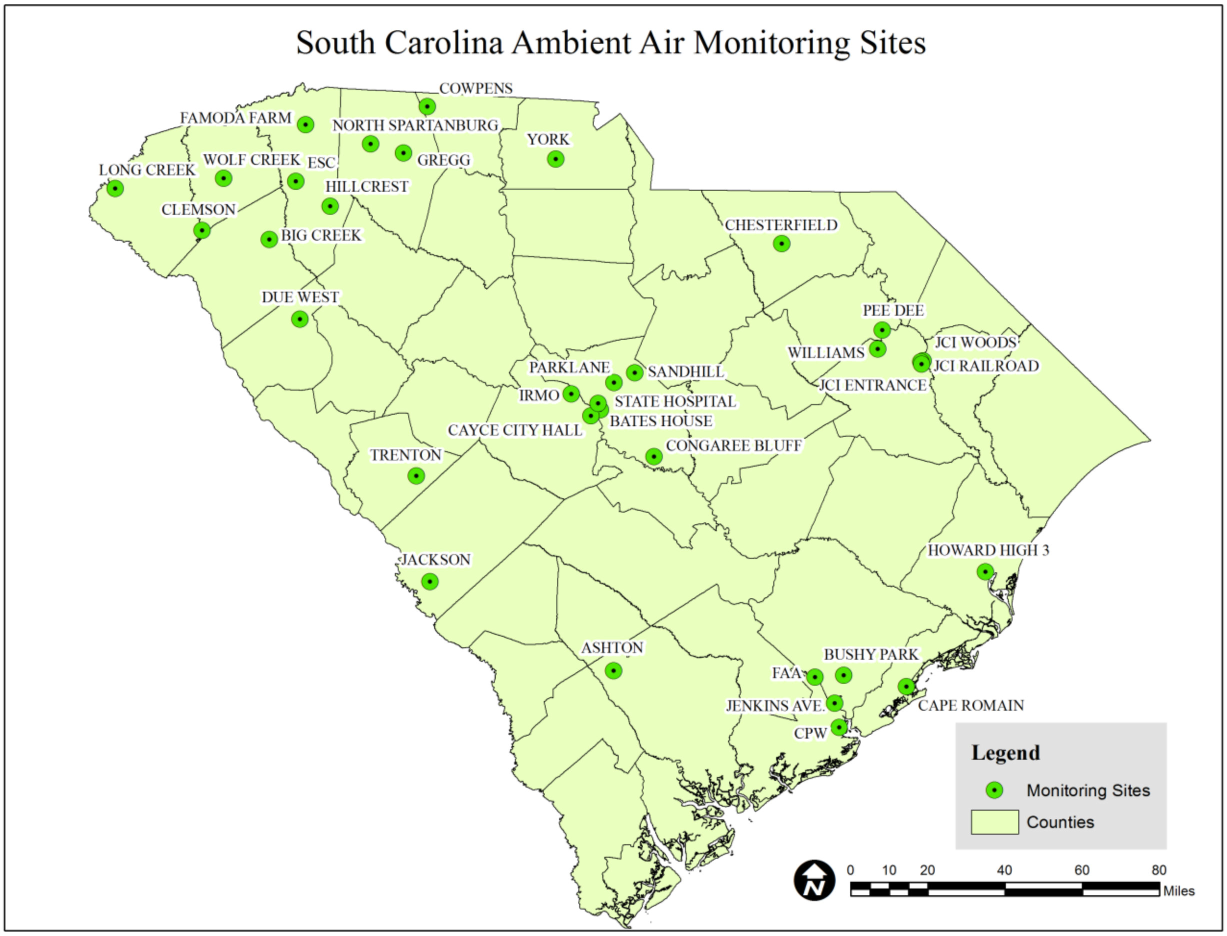
Scoring method

Each of the criteria listed in steps 2 and 3 produced a “ranked” score for each ambient air monitoring site. Appendix H lists the weights employed in this technique. The following steps were used in developing the “score.”

1. The Thiessen polygon technique described above was used to divide the ambient air monitoring network into regions defined by polygons. Each polygon contains only one site and shows the land area centered on and nearest to the monitoring site.
2. The zonal statistics of each parameter are summarized for each Thiessen polygon and reported in a table.
3. The tabular data for the appropriate parameter are then related to each ambient air monitoring site.
4. Each ambient air monitoring site was scored proportionately utilizing the formula (Value-Min)/(Max-Min).
5. The above steps are repeated for each parameter.
6. Scores for each category were multiplied by their weights listed in Appendix H and weighted scores were summed for all the categories. Each site was ranked based on the total score using equal intervals between classifications and identified as “low,” “medium” and “high” value. Final scores for Ozone and $PM_{2.5}$ monitors are represented in the “Results and Conclusions” section.

South Carolina's current ambient air monitoring network

As of January 1, 2015, South Carolina's ambient air monitoring network consisted of thirty-four sites measuring criteria pollutants. Ambient air monitoring sites are clustered in urbanized areas with several monitors located across the state in rural locations.



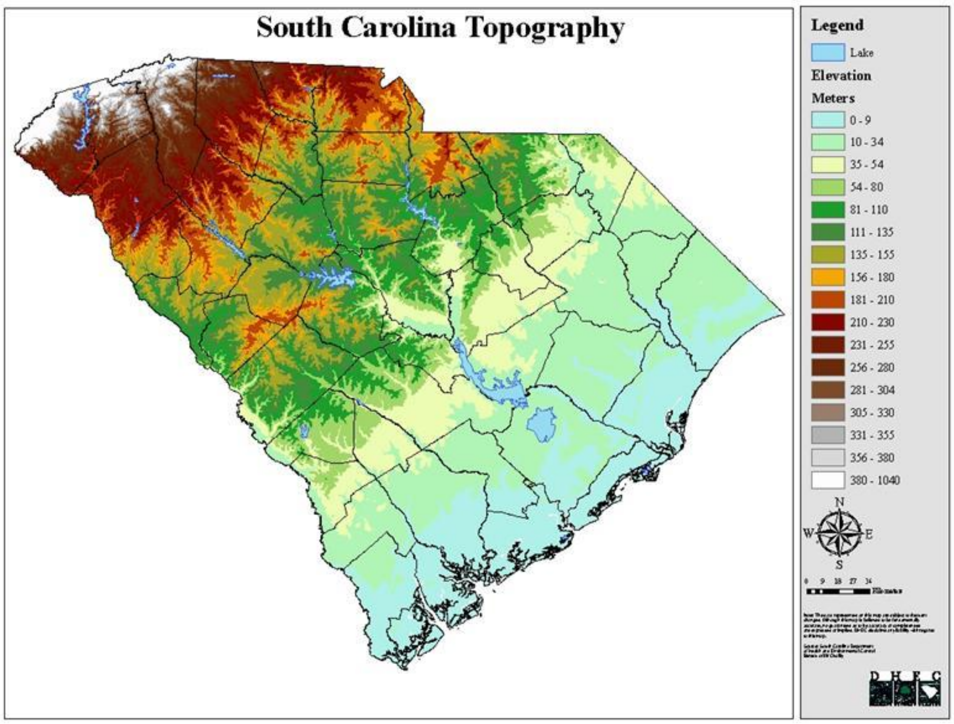
Technical analysis of South Carolina's ambient air monitoring network

Step 1: General information

Topography

The topography of South Carolina is divided into two distinct areas, commonly known as the Piedmont and the Coastal Plain. The line of demarcation runs from the eastern boundary of Aiken County through central Chesterfield County to the North Carolina border. West of this line, elevations begin at about 300 feet and increasing to over 1,000 feet in the extreme northwestern counties, culminating in isolated peaks of 2,000 to over 3,500 feet above mean sea level. East of the line, there are evidences of outcroppings from the lower Appalachians in a ridge of low hills and rather broken country between the Congaree River and the north fork of the Edisto River, and also in a rather hilly and rolling region in the upper Lynches River drainage basin between the Catawba-Wateree and the Great Pee Dee Rivers. In about one-third of the coastal plain (or what is commonly known as the upper coastal plain), the elevations decrease rather abruptly from 300 to 100 feet and continue to decrease to the coast. The major part of the coastal area is not over 60 feet above mean sea level. In this region of lower levels, to the eastward and southward, the great swamp systems of the state predominate.

The slope of the land from the mountains seaward is toward the southeast, and all of South Carolina's streams naturally follow that general direction to the Atlantic Ocean. The South Piedmont section of the state is on the eastern slope of the Appalachian Mountains with the main ridge of the mountains about 30 miles west. To some extent, these mountains act as a barrier for weather systems and tend to protect the area from the full force of the cold air masses during the winter months. The relatively flat areas of the Central Plains and the coastal region allow free air movement and are conducive to effective dispersion of pollutants.



Climate

South Carolina has a humid, subtropical climate, although high elevation areas in the state's northwest Blue Ridge region have less subtropical characteristics than the midlands and the Atlantic Coastal Plain and immediate coastal regions.

Summer is hot and humid with daytime temperatures averaging near or above 90° F (32° C) across most of the state and overnight lows near or above 70° F (21° C). Winter temperatures are not extremely cold and vary from the mild coastal areas with high temperatures averaging near 60° F (16° C) and overnight lows near 40° F (3° C) to the midlands averaging between 57° F (13° C) during the day and 36° F (1° C) at night. On average, between 40-80 inches of precipitation falls annually across the state. Tropical cyclones contribute to the precipitation during the summer and fall months, while extratropical cyclones contribute to precipitation during the fall, winter, and spring months. Severe weather can be a concern across the state during the spring months.

Further information and analysis of meteorological patterns in areas of South Carolina where ambient air monitoring is conducted can be found in Appendix D.

Monthly Normal High and Low Temperatures (°F) for Various South Carolina Cities												
City	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Charleston	59/38	63/41	70/47	76/53	83/62	88/70	91/73	90/72	85/67	77/57	70/48	62/40
Columbia	56/34	61/39	68/43	76/50	84/60	90/68	93/72	91/71	85/64	76/52	67/42	58/35
Greenville	52/32	57/35	65/41	73/48	80/57	88/66	90/69	89/69	82/62	73/50	64/41	54/34

Monthly Normal Precipitation Amounts for Various South Carolina Cities												
City	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Charleston	3.71	2.96	3.71	2.91	3.02	5.65	6.53	7.15	6.10	3.75	2.43	3.11
Columbia	3.58	3.61	3.73	2.62	2.97	4.69	5.46	5.26	3.54	3.17	2.74	3.22
Greenville	3.82	3.97	4.52	3.36	3.76	3.80	4.80	4.48	3.43	3.44	3.70	4.11

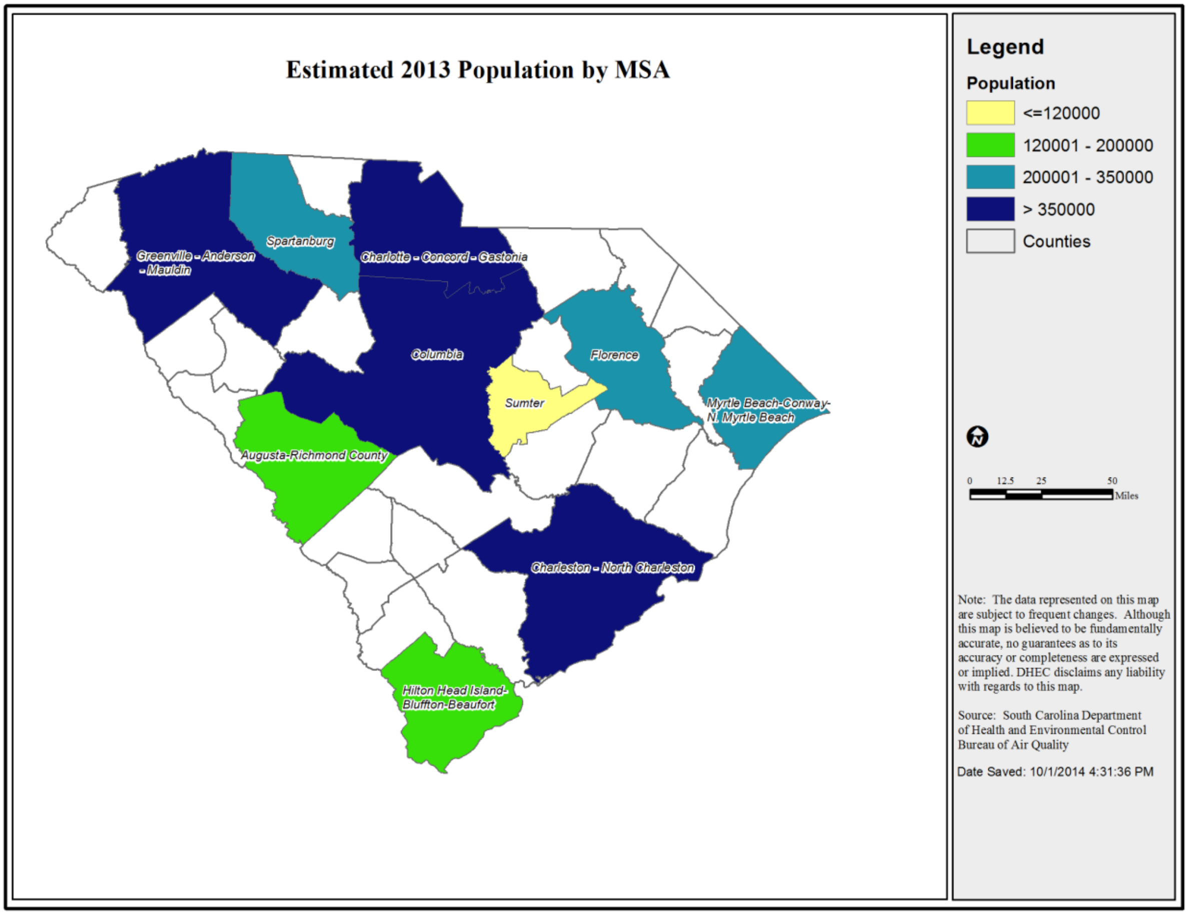
Population

As of 2013, South Carolina ranks as the twenty-fourth most populated state and the sixth most populous EPA Region 4 state (out of eight states). There are ten MSAs in South Carolina with three of these being multi-state MSAs.[7]

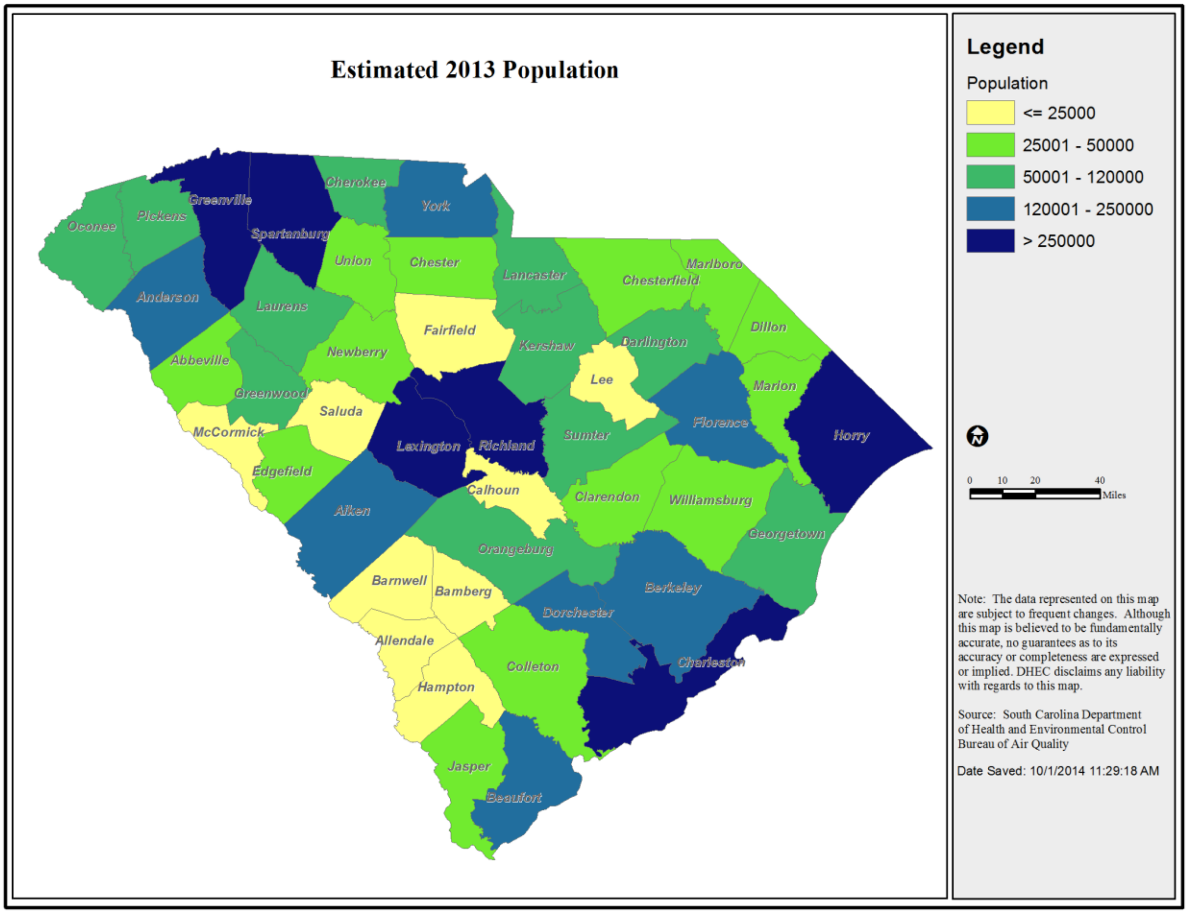
MSAs and micropolitan statistical areas (mSAs) are geographic entities defined by the U.S. Office of Management and Budget (OMB) for use by federal statistical agencies in collecting, tabulating, and publishing federal statistics. An MSA contains a core urban area of 50,000 or more population, and an mSA contains an urban core of at least 10,000 (but less than 50,000) population. Each MSA or mSA consists of one or more counties and includes the counties containing the core urban area, as well as any adjacent counties that have a high degree of social and economic integration (as measured by commuting to work) with the urban core.

[7] Population estimates from US Census, http://www.census.gov/programs-surveys/popest.html, accessed 3/18/2015.

The map below shows South Carolina's MSAs, the location of current ambient air monitoring sites, and the population contained within them. South Carolina's largest MSAs contained wholly within the state are Charleston-North Charleston, Columbia and Greenville. York County is part of the larger Charlotte-Gastonia-Concord NC/SC MSA. Horry County is part of the Myrtle Beach-Conway-North Myrtle Beach MSA that is shared with Brunswick County in North Carolina. Aiken and Edgefield counties are part of the Augusta-Richmond County GA/SC MSA.

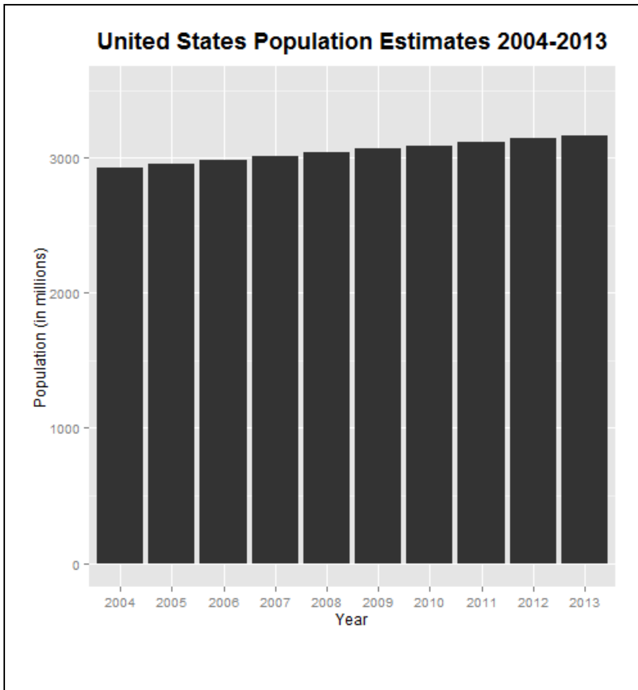


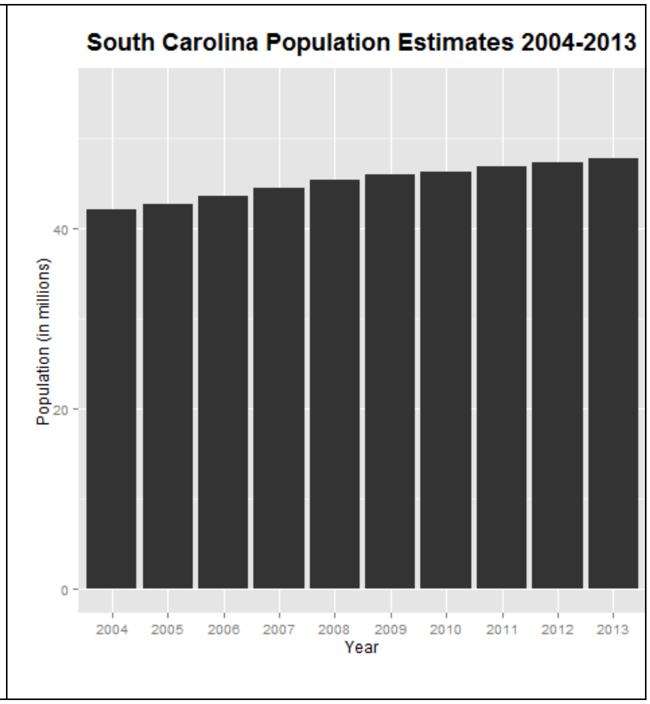
The most populated counties in South Carolina are Horry, Lexington, Charleston, Richland, Greenville and Spartanburg. These counties form the core areas of each of their respective MSAs and are areas of the state where the most ambient air monitoring is conducted.



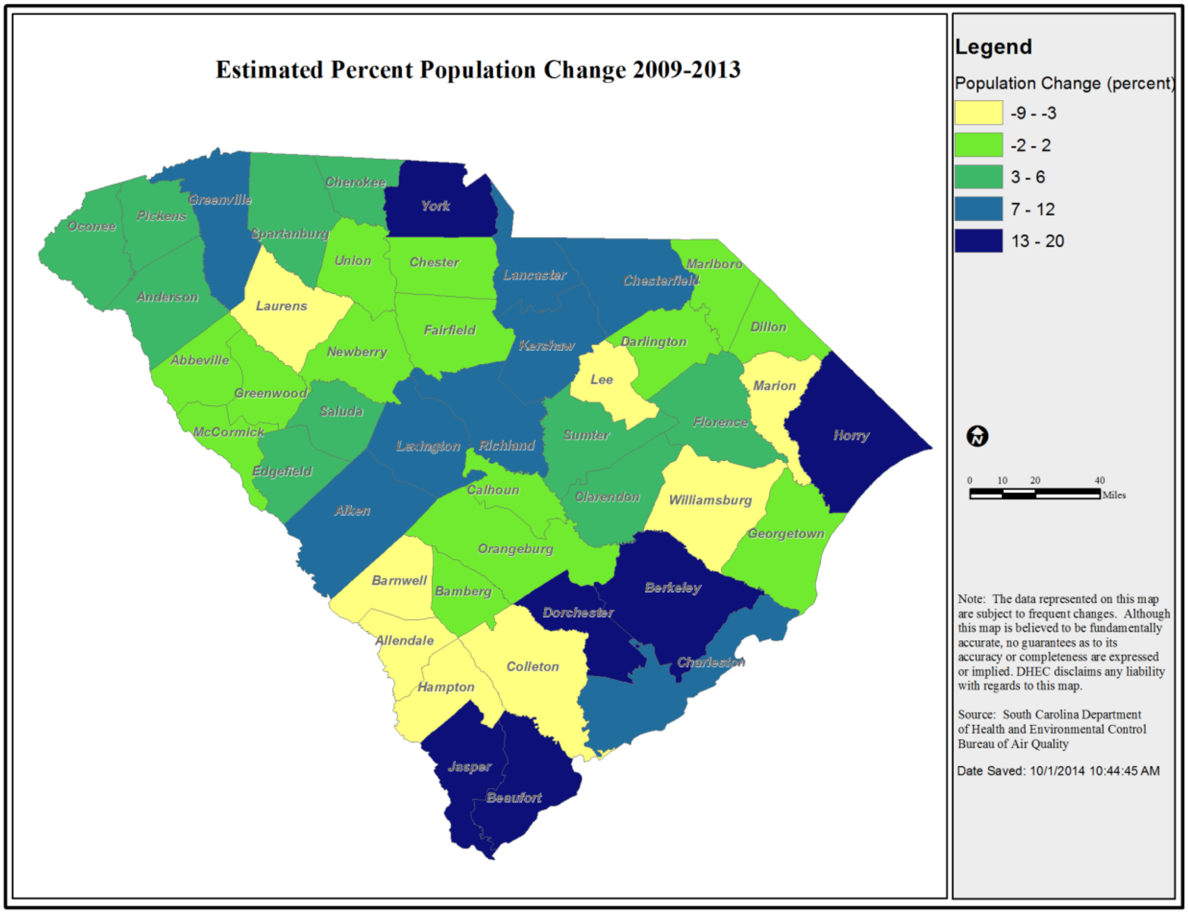
Demographics and trends

According to the U.S. Census Bureau, South Carolina had a 2013 estimated population of 4,771,929, which is an increase of 49,308 from the prior year and an increase of 135,639, or 2.93%, since the year 2010. This percent increase ranks as the sixteenth largest in the United States and third largest of the EPA Region 4 states.



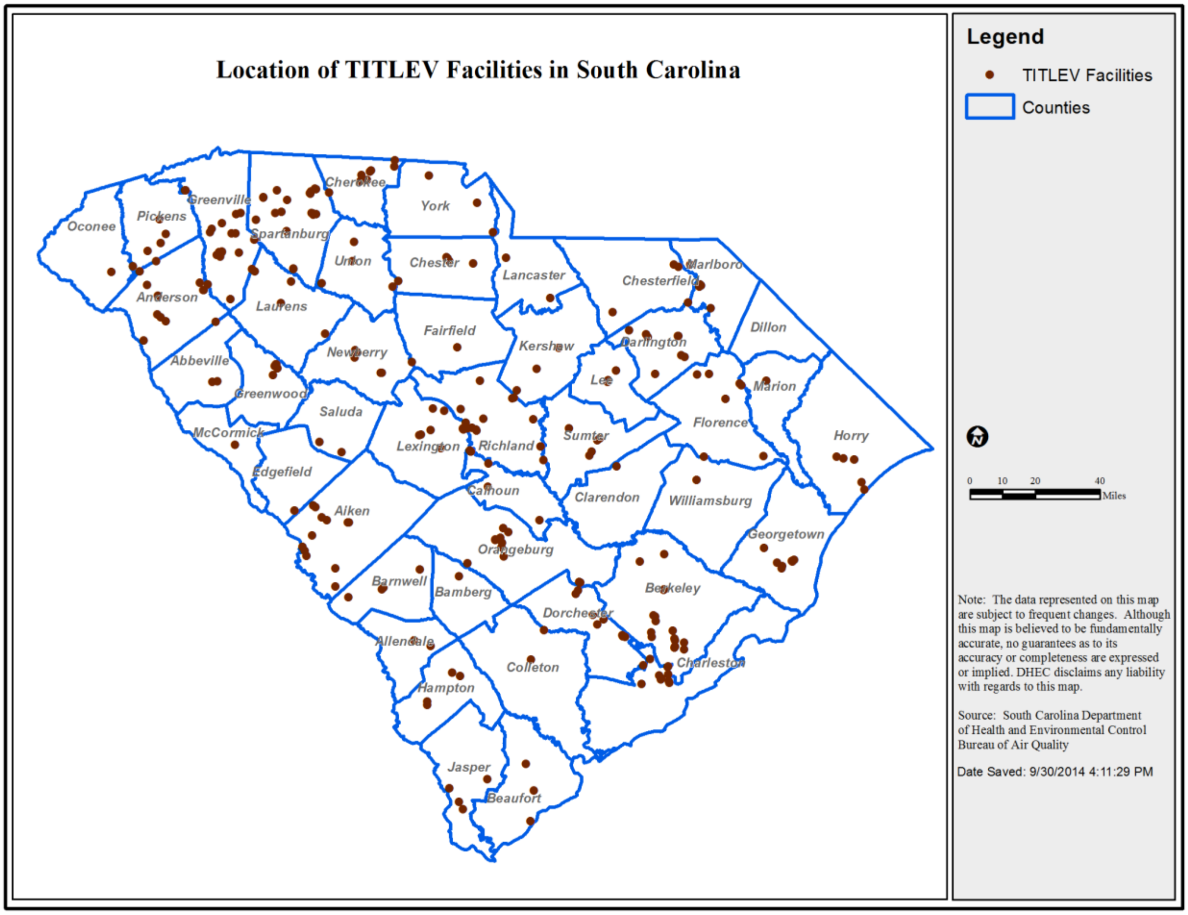


From 2009 to 2013, overall population growth occurred mainly along the coast of South Carolina and in the major urbanized areas of the state. Population decreases were mainly seen in more rural areas of the state.



Sources of emissions

Currently, there are 271 Title V sources in South Carolina emitting one or more of the criteria pollutants. These sources are scattered fairly uniformly across the state with some clustering near urbanized areas and along interstates.



South Carolina has three types of operating permits: state minor, conditional major and Title V. The type of permit issued is dependent on potential emissions and limits: Potential emissions are calculated on 8,760 hours per year operation, maximum capacity, using worst case emitting material and no emission controls. A facility can add emission controls or other operating limits (such as hours of operation) if those limits are an enforceable limit in the permit.

The types of permits South Carolina issues to facilities include:

- **Title V** is a major source operating permit classification. Facilities with the potential to emit over 100 tons per year of any Title V pollutant (PM_{10}, SO_2, NO_x, CO, VOC) are subject to this type of permit. Facilities that can potentially emit 10 tons per year of a single hazardous air pollutant (HAP) or 25 tons per year of total HAPs are also subject. Facilities subject to Title V permitting program must also certify compliance with their permit each year.

- **Conditional major** is a permit type for facilities with potential emissions above 100 tons per year (or are above the 10/25 tons per year), but who have taken enforceable limits to stay below 100/10/25 tons per year. Facilities that have taken limits on their potential to emit also have reporting requirements related to their compliance.

- A **State** minor facility's potential emissions are below 100 tons per year for criteria pollutants and below 10 and 25 tons per year for HAPs.

Maps of countywide emissions, along with graphs containing contributions from the major source categories for all criteria pollutants can be found in Appendix E.

Air quality data 2009 - 2013

A summary of the current air quality, along with trends in the data over the last five years for South Carolina can be found in Appendix F.

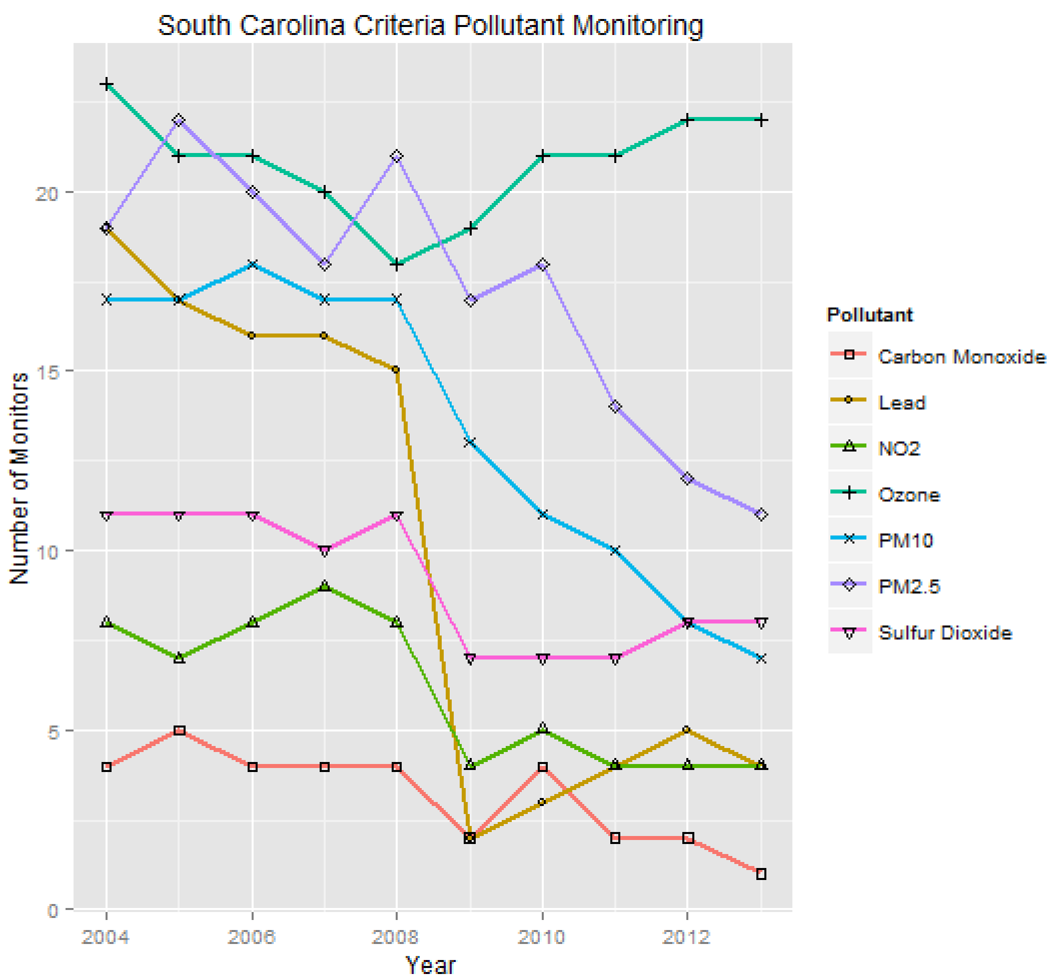
Step 2: History of ambient air monitoring in South Carolina

The Department or its predecessors have operated an ambient air monitoring network in South Carolina since 1959. Since that time, the network has continually evolved to meet the requirements and needs of the Department's Air Program and to comply with federal requirements.

In October, 2006, the EPA published revisions to the ambient air monitoring regulations[8] changing requirements for quality assurance, monitor designations, minimum requirements for both number and distribution of monitors among MSAs, and probe siting. The regulation also included the requirement for an annual ambient air monitoring network plan and periodic network assessments.

[8] Revisions to Ambient Air Monitoring Regulations; Final Rule 71 FR 61236 published in the *Federal Register* on October 17, 2006.

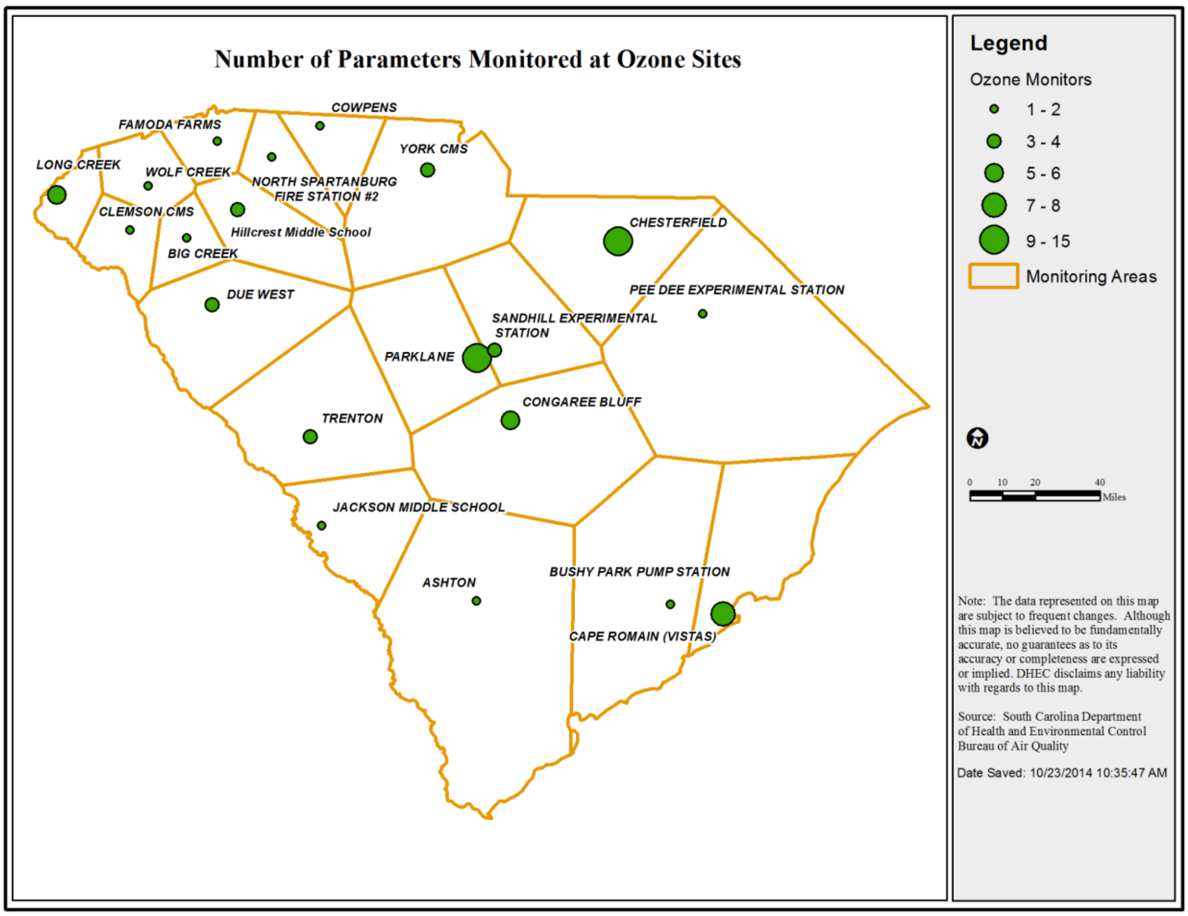
Until 2008, the number of monitors for each criteria pollutant remained fairly stable with the exception of $PM_{2.5}$. The $PM_{2.5}$ network was established in response to the development of the 1997 $PM_{2.5}$ NAAQS, and was drastically increased in order to meet the requirements of the rule. In 2008, a number of lead sampling sites were terminated because data indicated ambient lead concentrations were well below the NAAQS. As a result of the 2006 ambient air monitoring regulations changes and the comprehensive review mentioned above, South Carolina discontinued much of the monitoring of pollutants that did not have historical problems meeting the NAAQS, and, instead, focused on conserving resources to meet the challenges associated with tightening standards.



The following tests were adapted from the EPA's network assessment guidance document. An example graphic is provided after the description for each test. The graphics for both Ozone and $PM_{2.5}$ can be found in Appendix G.

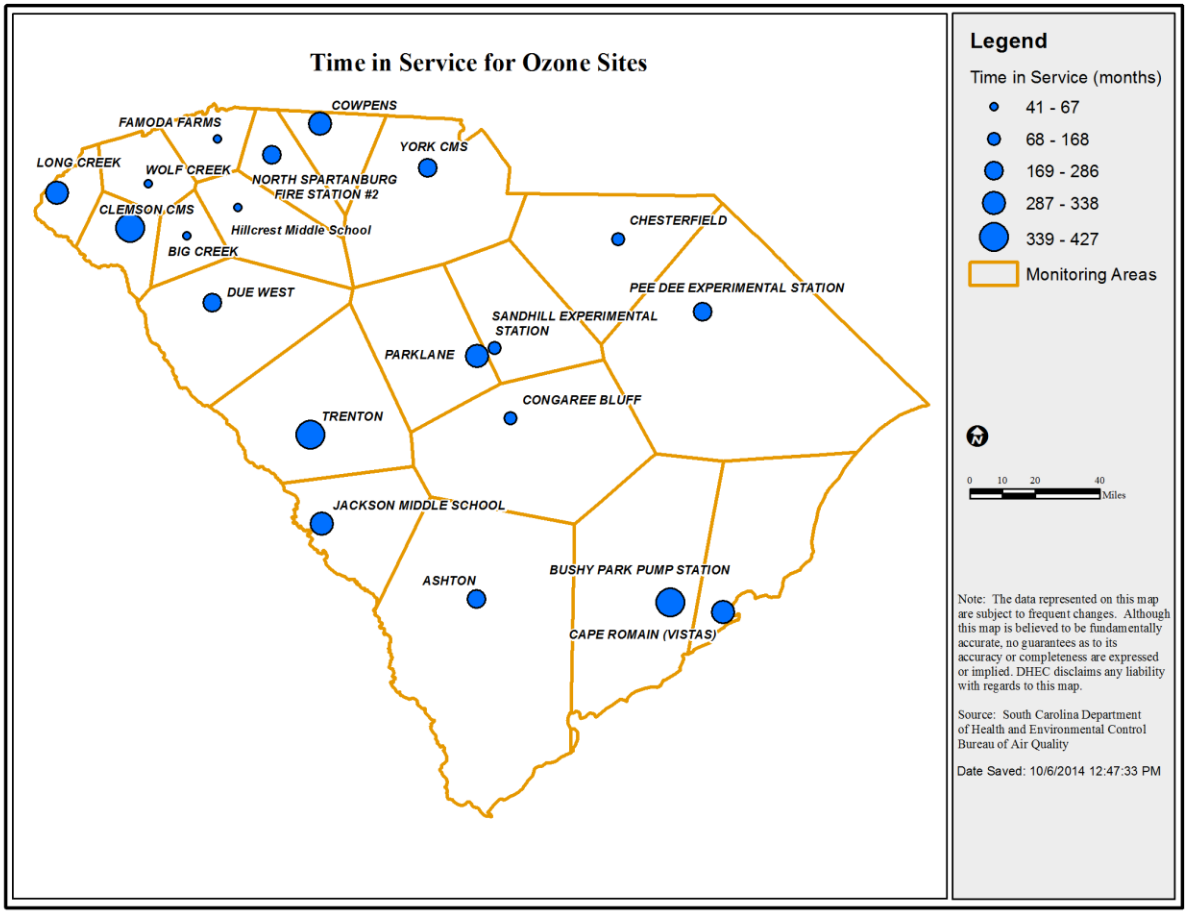
Number of other parameters monitored at the site

Sites were ranked by the number of parameters that are measured at a particular site. Air quality monitoring sites hosting monitors collocated with other measurement instruments are likely more valuable than sites at which fewer parameters are measured. In addition, the operating costs can be leveraged among several instruments at these sites. This analysis is performed by simply counting the number of other parameters that are measured at a site. Sites at which many parameters are measured are ranked highest.



Monitor time in service

Monitors that have a long historical record are valuable for tracking trends. In this analysis, monitors were ranked based on the duration of their continuous measurement records. The analysis can be as simple as ranking the available monitors based on the length of the continuous sampling record. For the purposes of this evaluation, the most important monitors are those with the longest continuous trend record.



Step 3: Statistical analysis of the ambient air monitoring network

The technical tools initially provided by the EPA and developed by SCDHEC for assessing monitoring networks have made it possible to conduct a more in-depth review of Ozone and $PM_{2.5}$ FRM ambient monitoring. These tools are more appropriate for large monitoring networks that are widely distributed over larger geographic areas. Therefore, only the Ozone and $PM_{2.5}$ FRM networks were assessed with the full array of tools due to the size and spatial distribution of the monitors/samplers across the state. Because the remaining criteria pollutant networks are not of sufficient size to provide reasonable results using tools provided by the EPA, these networks were evaluated based on the requirements as specified by 40 CFR 58.10 (d), associated guidance, and their perceived value to the Air Program. Appendix B to this document provides the assessment rating and recommendations for optimizing the ambient air monitoring network.

Each of the tests used in the assessment is described in this section. Graphics for the Ozone and PM2.5 networks can be found in Appendix G. The following tests were adapted from the EPA's network assessment guidance document[9].

Area served

Sites were ranked based on their area of coverage. Sites that are used to represent a large area score highest in this analysis. Area of coverage (area served) for a monitor has been estimated using the Thiessen (Voronoi) polygons technique. Each polygon consists of the points closer to one particular site than any other site. The use of this technique gives the most weight to rural sites and those sites on the edges of urban areas or other monitor clusters. Calculating Thiessen polygons is one of the simplest quantitative methods for estimating an area represented by a site, but it is not an accurate indication of which site is most representative of the pollutant concentration across a given area. Meteorology (including pollutant transport), topography, and proximity to population or emission sources are not considered, so some areas assigned to a particular monitor may actually be better represented by a different monitor.

Measured concentrations

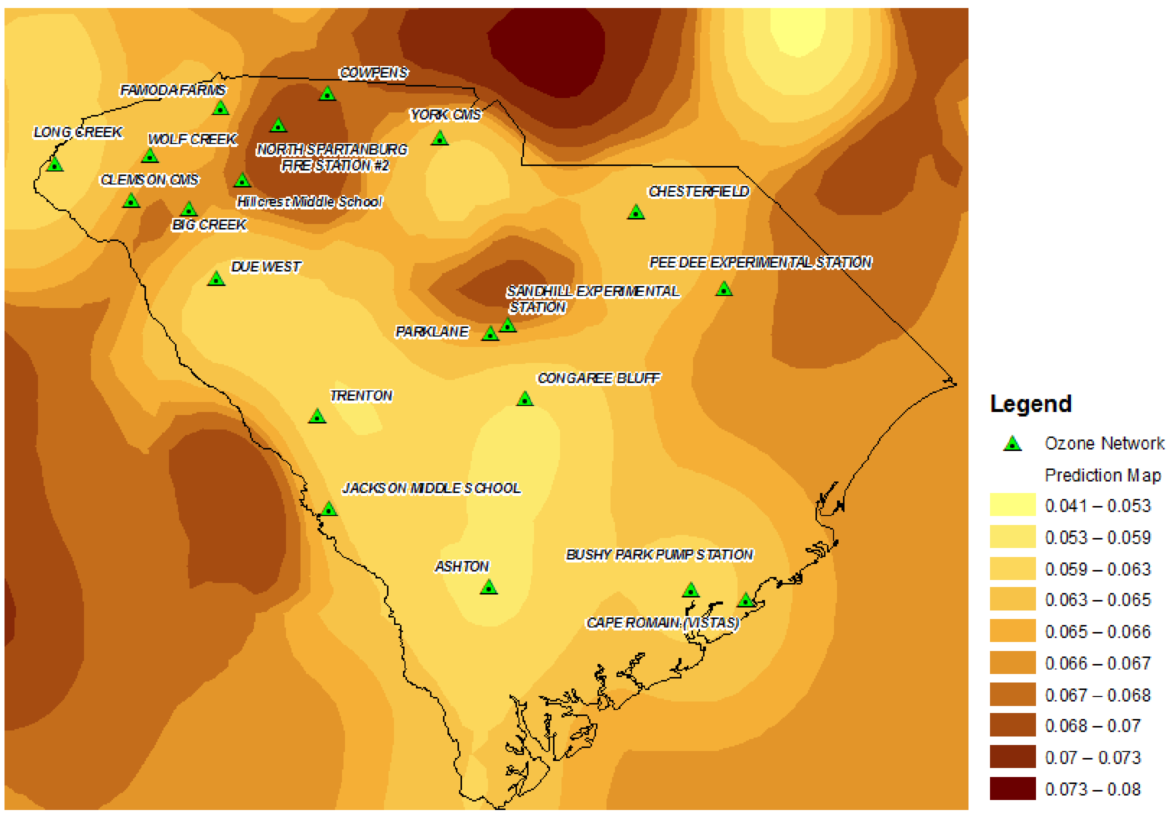
Individual monitors were ranked based on the concentration of pollutants they measure. Monitors that measure high concentrations or design values[10] are ranked higher than monitors that measure low concentrations. The analysis is relatively straightforward, requiring only the site design values. The greater the design value, the higher the site rank. If more than one standard exists for a pollutant (e.g., annual and 24-hr average), monitors can be scored for each standard. Appendix C contains the 2013 Design Values for each of the criteria pollutants.

[9] http://www.epa.gov/ttnamti1/files/ambient/pm25/datamang/network-assessment-guidance.pdf

[10] A design value is a statistic that describes the air quality status of a given area relative to the level of the NAAQS.

The Department used 2013 design values for Ozone and $PM_{2.5}$ sites to rank the ambient air monitoring sites. There was not enough data to calculate the design values for some of the newer sites recently placed in service. However, in order to score and evaluate all ambient air monitoring sites, the Department predicted the concentrations through geostatistical techniques. The concentration values for the new Ozone monitors were predicted using Kriging. Kriging is a geostatistical technique used to create surfaces incorporating the statistical properties of the measured data. To make a prediction for an unknown concentration value at the specific location, Kriging uses the fitted model from variography (spatial autocorrelation), the spatial data configuration, and the values of the measured sample points around the prediction location. The autocorrelation is a function of distance. Sites that are closer together are considered to be more alike than farther apart. The figure below shows a surface map of predicted Ozone values.

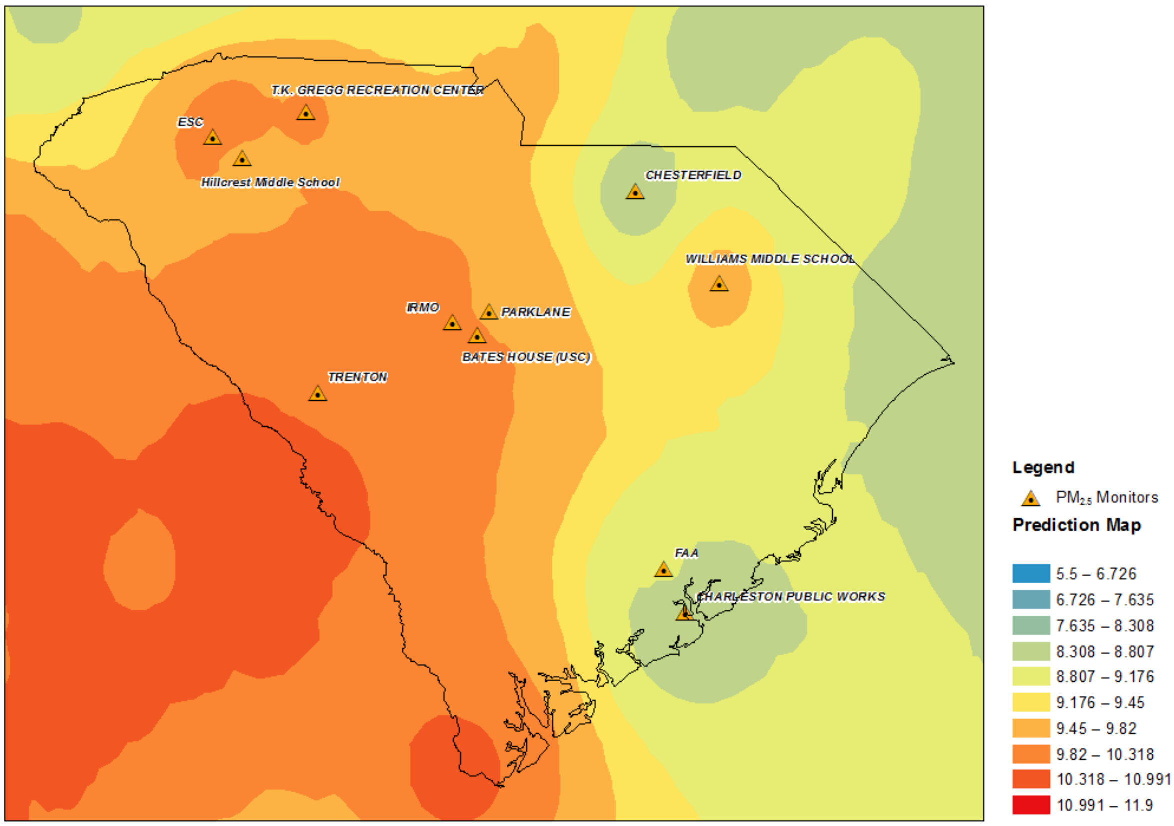
Predicted Ozone Design Values Using Kriging



Due to the spatial distribution of $PM_{2.5}$ FRM monitors operating in South Carolina, Kriging did not produce results sufficient to predict values for the new ambient air monitoring sites. The Inverse Distance Weighted (IDW) method of interpolation was used to estimate $PM_{2.5}$ values at these locations. IDW is a deterministic method of interpolation and it creates a surface from the measured points based on the extent of similarity. It is based on the premise that the values at close proximity to each other influence the interpolation more that than the distant observations. In order to compare the IDW and Kriging methods, the difference between the recorded $PM_{2.5}$ data and the interpolated $PM_{2.5}$ as the predicted data for the twelve $PM_{2.5}$ monitors were calculated. The IDW method was used because the difference between predicted and actual values for the existing monitors was smaller than the range in the Kriging method.

The surface of predicted $PM_{2.5}$ values is shown below. Monitors that measure high concentrations or design values and their estimated values are ranked higher than monitors that measure low concentrations.

Predicted $PM_{2.5}$ Values Using Inverse Distance Weighting



Deviation from NAAQS

Sites measuring concentrations or design values that are very close to the NAAQS exceedance threshold are ranked highest in this analysis. These sites may be considered more valuable for NAAQS compliance evaluation. Sites measuring concentrations well above or below the threshold do not provide as much information in terms of NAAQS compliance. This technique contrasts the difference between the standard and actual measurements or design values. It is a simple way to assess a site's potential value for evaluating compliance. If a pollutant (e.g., annual and 24-hr average) has more than one standard, sites can be scored for each standard.

Emission inventory

Emission inventory data were used to find locations where emissions of pollutants of concern are concentrated. This analysis can be scaled to various levels of complexity, depending on available resources. At the simplest level, county-level emissions patterns, such as those in the National Emission Inventory, can be compared with monitor locations. For measuring maximum precursor or primary emissions, monitors should be placed in those counties with maximum emission density. More complex methods use gridded emissions and/or species-weighted emissions, depending on their importance in producing secondary pollutants of concern.

Population change

High rates of population increase are associated with potential increased emissions activity and exposure. Sites were ranked on population change in the area of representation. Area of representation was estimated using the Thiessen polygons technique. The total population change at the census tract or block group level that falls within the area of coverage of a monitor is assigned to that monitor. This technique gives most weight to sites in areas with high rates of population growth and large areas of representation.

Population living below poverty level

This test is similar to the population change test except that it focuses on rates of poverty in the areas represented by each ambient air monitoring site. Area of representation was estimated using the Thiessen polygons technique. The total population living below the poverty level at the census tract or block group level that falls within the area of coverage of a monitor was assigned to that monitor. As stated earlier, the Thiessen polygons tend to be larger in more rural areas because ambient air monitoring networks tend to be concentrated in urbanized areas. Sites were ranked on the population living below the poverty level in the area of representation (as determined via the Thiessen polygon technique).

Population for age 18 and below

This test is similar to the population change test except that it focuses on the total population of younger individuals represented by each ambient air monitoring site. Areas with high populations of youth may be indicative of the effects of pollution on sensitive individuals. Sites were ranked on the population below age eighteen in the area of representation. Area of representation was estimated using the Thiessen polygons technique. The population of a county whose center falls within the area of coverage of a monitor is assigned to that monitor.

Population for age 65 and above

This test is similar to the population change test except that it focuses on the total population of older individuals in the area represented by each ambient air monitoring site. Areas with high populations of older individuals indicate the potential for the effects of pollution on sensitive individuals. Sites once again were ranked on the population of older individuals in the area of representation. Areas of representation were estimated using the Thiessen polygons technique. The population of a county whose center falls within the area of coverage of a monitor is assigned to that monitor.

Step 4: Situational analysis

Risk of future NAAQS exceedances

Appendix A contains calculations designed to predict the risk of a future NAAQS exceedance for each of the criteria pollutants. The purpose of this test is to see which sites are most likely to exceed the applicable NAAQS in the next three years based on previous data trends. In general, all Ozone, some $PM_{2.5}$, and some PM_{10} sites will exceed a 90 percent probability of exceeding 80 percent of the applicable NAAQS in the next three years.

Requirements of existing state implementation plans or maintenance plans

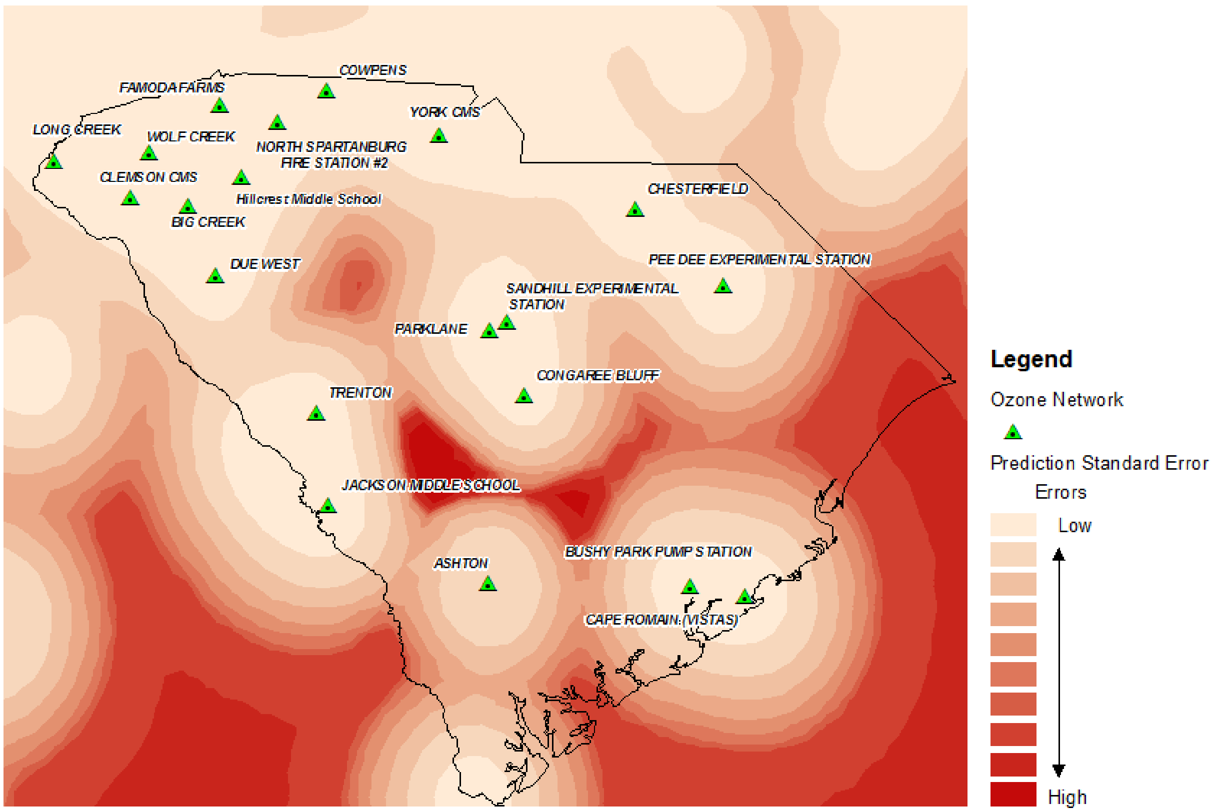
There are no monitoring requirements for existing state implementation plans or maintenance plans in South Carolina.

Density or sparseness of existing networks

As stated earlier, due to the spatial distribution of the South Carolina $PM_{2.5}$ FRM network required by the Network Design Criteria found in Appendix D to 40 CFR 58, Kriging did not produce results sufficient to predict concentrations throughout the state. The IDW method of interpolation to estimate $PM_{2.5}$ concentrations is a deterministic method that does not allow for the estimation of error in the prediction surface used to indicate potential gaps in the ambient air monitoring network. Due to this limitation in the available tools, the Department was unable to evaluate the density or sparseness of the $PM_{2.5}$ FRM ambient air monitoring network to measure concentrations throughout the state, but does have high confidence, based on studies of $PM_{2.5}$ concentration variability in urban areas, that the primary monitoring objectives are being met by the existing network. South Carolina's $PM_{2.5}$ FRM ambient air monitoring network meets or exceeds the ambient air monitoring network design requirements in Appendix D to 40 CFR 58.

These analyses were conducted to determine where additional ambient air monitoring may be needed. The analyses included creating a predicted Ozone surface described in the previous section and a map of standard errors associated with the Ozone predicted values. With the Kriging technique, an error or uncertainty surface was produced, indicating how well the values were interpolated. The map of standard errors is shown below. Areas in darker brown color have higher error associated with their interpolated concentrations.

Predition Standard Error Map for Ozone

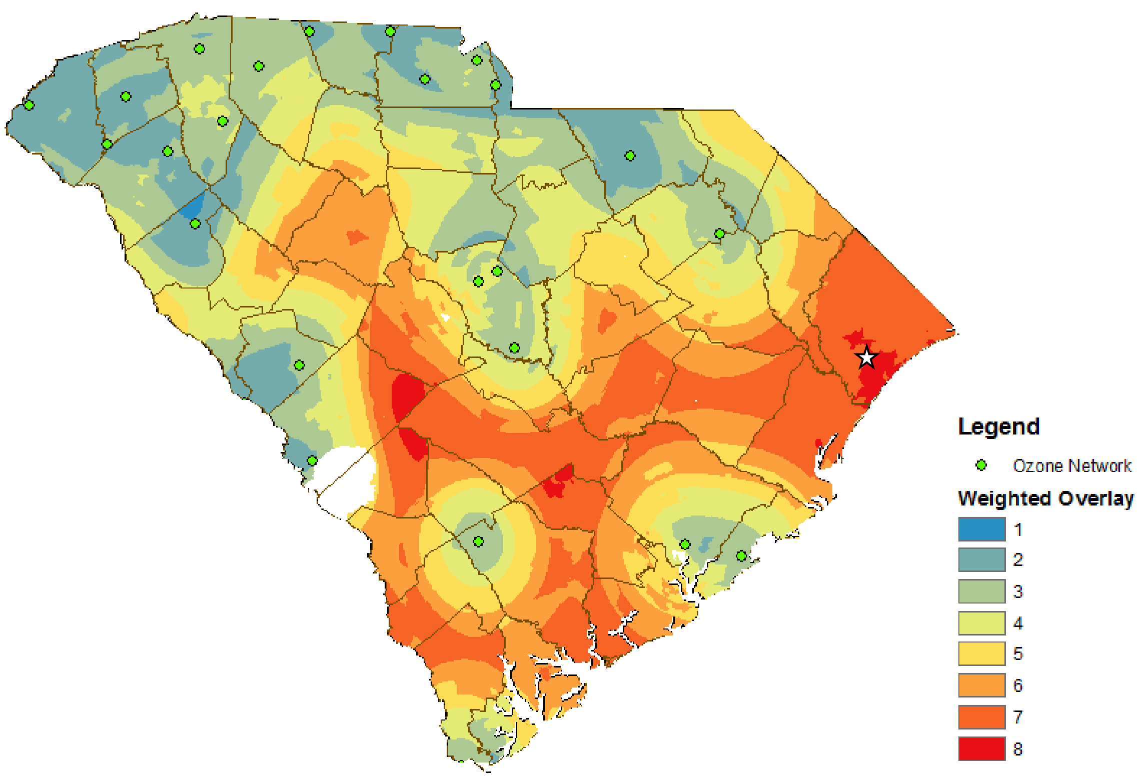


Prediction standard error, distance to roads, population, NO_x emissions, and VOC emissions grids were input to the weighted overlay analysis. The rasters were reclassified to a common scale of 1 to 10 (1 being the least suitable, 10 being the most suitable for placing new monitors). Each raster was assigned the percentage weights. Since the prediction standard error provided the most information about the uncertainty of the network, it was given the highest percentage weight. The rasters were overlain to produce the final suitability map for placing new monitors. The weighted overlay allows the user to look at the areas with the highest suitability and where the uncertainty of the network is the greatest and place new monitors if needed. The model was built and documented with the ModelBuilder[11] application within the Department's GIS program to ensure that the whole process could be easily repeated. The map below shows the suitability map and depicts the areas for possible new monitor selection. The color red indicates where new Ozone ambient air monitoring sites may be placed. This analysis indicates that a gap in

[11]An explanation of what ModelBuilder does can be found at:
http://webhelp.esri.com/arcgisdesktop/9.2/index.cfm?TopicName=An_overview_of_ModelBuilder

coverage may exist for Ozone ambient air monitoring in eastern South Carolina, although the upper eastern coastal area now has an Ozone monitor. The Department has monitored in the vicinity of this potential gap in Williamsburg County. The Indiantown site (45-089-0001) was operated through 2007 and indicated area concentrations were well below the 1997 Ozone NAAQS and correlated well with other monitors in the coastal plain of South Carolina. As a result of the 2007 review of the ambient air monitoring network mentioned elsewhere in this document, the Indiantown site was determined by the Department to be redundant and the EPA concurred with this assessment. Due to changes in 2015 MSA definitions which added Brunswick County, North Carolina to the Myrtle Beach-North Myrtle Beach-Conway MSA, a new ozone monitoring site is now located in Horry County (see star on map below), which should address most of the indicated gap in monitoring in eastern South Carolina. Finally, the gap in spatial coverage northeast of Columbia will be addressed in a future special study the Department intends to conduct. Details of the monitoring project can be found in the Network Development section of the 2017 Network Description and Ambient Air Network Monitoring Plan.

Suitability Map for Ozone Network



Scientific research or public health needs

As of this writing, the EPA has yet to provide details on any health studies or scientific research that utilizes South Carolina ambient air monitors. The Department currently knows of no local studies that depend on any site/monitor suggested for removal.

Step 5: Suggested changes based on assessment

Appendix B presents the results of the assessment and some potential realignment recommendations that are possible for the network. The Coastal Carolina Site in Horry County was added on July 27, 2016 and represents the Myrtle Beach-Conway-North Myrtle Beach MSA.

Step 6: Availability of assessment

The Department will make this assessment available on the internet at www.dhec.sc.gov.

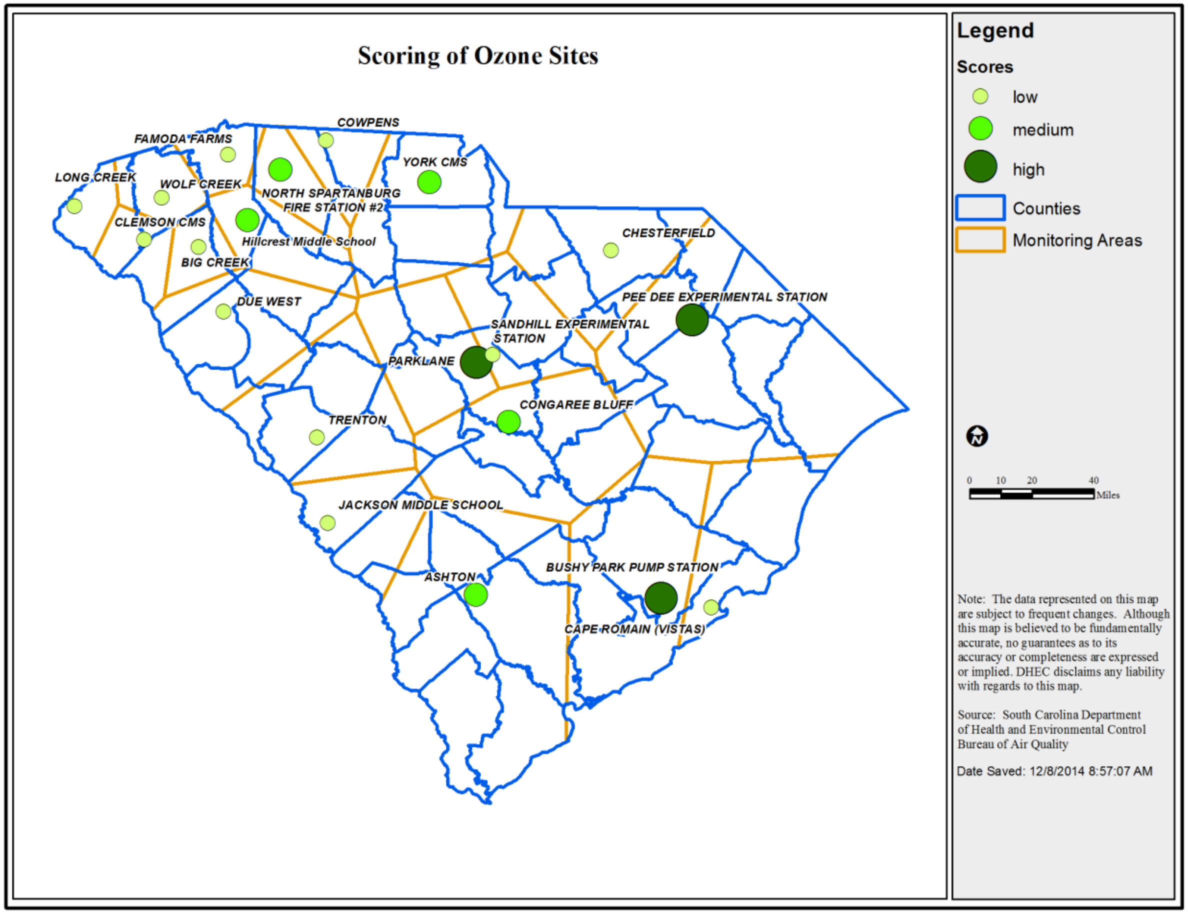
New Technologies

The Department is currently working to upgrade to broadband/cellular modems at all monitoring sites in order to switch to a digital network to take advantage of increased data throughput for instrument diagnostic data. Furthermore, the incorporation of low cost sensors may at some point in the future be incorporated into the operation of the monitoring network. Low cost sensors could help in siting and evaluating monitoring locations and is appealing to the Department because of ease of deployment and data acquisition. While these sensors are not intended to fulfill the role that of a traditional ambient air monitoring station, there is the potential that these sensors can help confirm appropriate scaling of monitors and aid in understanding spatial variations in ambient pollutant concentrations.

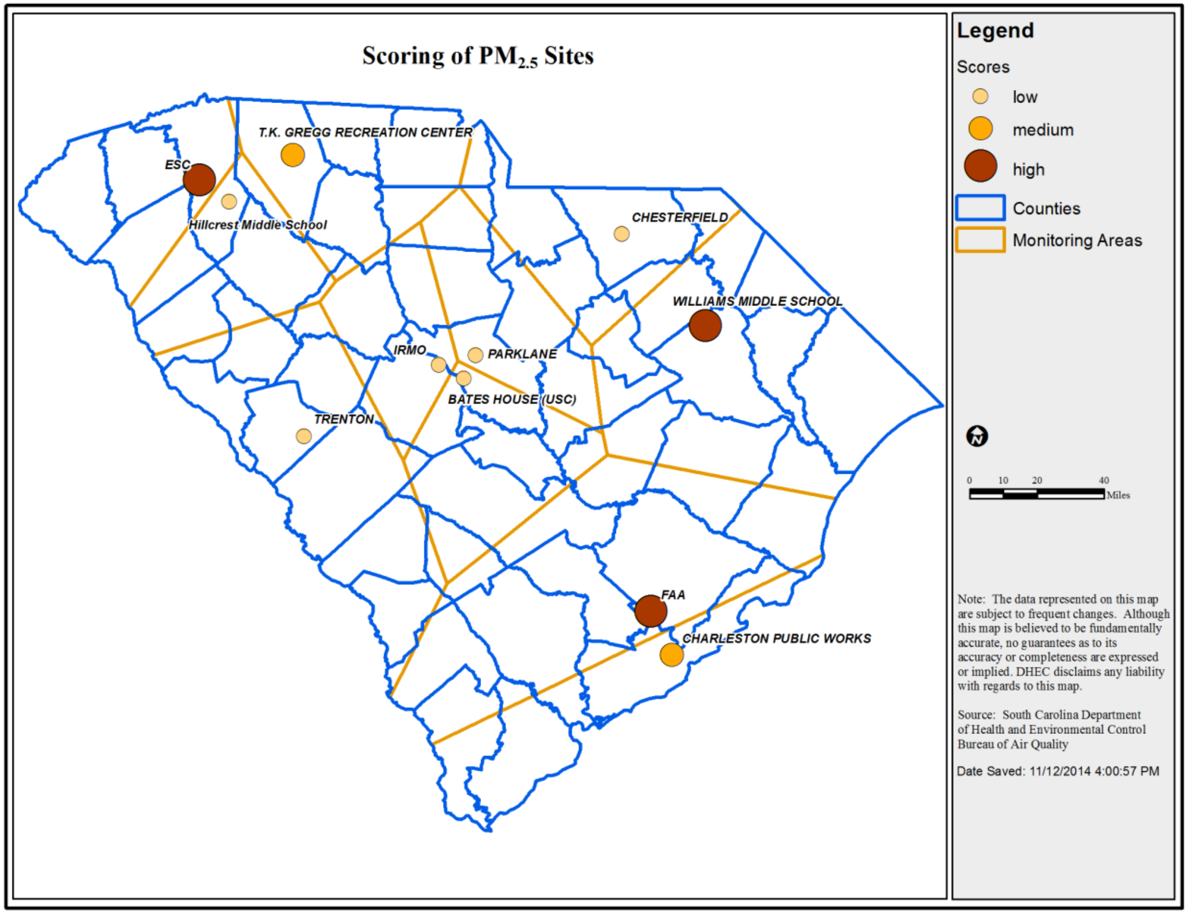
Results

The use of the EPA's technical tools resulted in a final ranking for the Ozone and $PM_{2.5}$ monitoring networks of the most and the least valuable sites. The three Ozone monitors that were scored highest included Pee Dee in Darlington County, Parklane in Richland County, and Bushy Park in Berkeley County. The scoring technique gave the most influence to rural areas since the statistics were gathered and analyzed for Thiessen polygons. The Pee Dee monitor had the highest score because it represents the largest area. The Parklane and Bushy Park monitors are located in or near highly populated counties in our state.

Based on the design values for 2013, all South Carolina monitoring sites attain the 2008 ozone standard. The three Ozone monitors scoring the lowest are located in the Upstate of South Carolina where there are a number of redundant monitoring sites.



The three most valuable $PM_{2.5}$ monitors based on their ranking are Williams Middle School in Florence County, Greenville ESC in Greenville County, and FAA in Charleston County. Two of these three sites represent highly populated areas. The two $PM_{2.5}$ monitors with the lowest scores are Chesterfield in Chesterfield County and Hillcrest in Greenville County.



Conclusions

This ambient air monitoring network assessment has been a combination of objective evaluations (e.g. "Is it required?") and subjective (We need the data…) evaluations, moderated by the capabilities and resources available (Can we do it?). The monitoring network has evolved from the simple exposure monitors of the 1960's to the sophisticated Federal Reference-Federal Equivalent methods and near real time data management systems in use today. The States were strongly encouraged in the 1990's to divest from the pollutants where significant progress had been made (SO_2, NO_x, Lead, and CO), to the point where there were no monitoring requirements at all for those pollutants. In 2007, South Carolina invested considerable effort in a site by site, parameter-by-parameter review of the ambient monitoring network, reflected in the significant changes proposed and implemented in the 2008 Network Description and Ambient Air Network Monitoring Plan.

The 2007 review and assessment was performed without the benefit of the applications described in the EPA Network Assessment Guidance or the tools made available in late 2009 and early 2010, but met the goals stated in the proposal to '… probe the current and expected relevancy of air monitoring networks through a combination of stakeholder participation and technical analyses.' Some portions of the network were reduced and some monitoring beyond the minimum required was maintained to meet the Air Program's objectives and data needs.

This 2015 review built upon the significant investment in time and resources developed for the 2010 assessment. The execution of this second mandated 5-year assessment and our previous experience leads us to the same broad conclusions that we reached in 2010:

Regular periodic assessment of the network is necessary to ensure that requirements and objectives are being met. A review of requirements and objectives is already a part of the Annual Monitoring Network Plan, but a broader, more strategic review of the network described in the proposal and rule preambles is appropriate and necessary.

The tools available are inadequate for an objective assessment at the scales needed for our State. The tools provided by EPA to assist the states for this scheduled assessment, or developed by South Carolina using national and regional guidance cannot provide actionable results with the limited resolution of the monitoring, emissions, population demographics, and health outcomes data that are readily available. Monitoring and supporting data does not (and typically will not) have the spatial resolution to allow adequate network assessment at the scale where most needed - the urban area or MSA. This is a particular concern at neighborhood and smaller scales associated with requirements for near road and source oriented monitoring.

Subjective evaluation of the value of monitoring data must be supported by, but not subordinate to objective (technical or statistical) evaluation. The local knowledge of communities, industries, traffic patterns, weather, topography and data needs are more important in the design and evaluation of a monitoring effort than the generalizations provided in the available descriptive data.

The basis of network design in South Carolina has been the collection of data to document concentrations and exposure throughout the state, providing data that represents relatively remote areas, rural areas, and smaller communities as well as the urban areas, which are the focus of the EPA monitoring requirements. The value of monitoring for background, transport and context was indicated in early network design requirements. The state has maintained monitoring for all criteria pollutants, in addition to the primarily urban-centric Ozone and $PM_{2.5}$ requirements to meet the full range of monitoring objectives. The value of context is being recognized again in the new and proposed requirements to monitor for background, transport and in smaller MSAs and non-urban areas – almost all of which can be met with our existing monitors.

The tools that have been developed are an improvement – the next generation – of methods used in the EPA Regional ambient air monitoring network assessments completed in 2005. The tools are most useful and appropriate for regional and national scale assessment of the monitoring effort and data. EPA must take the experience gained by the states and local monitoring organizations in the development of these assessment documents and continue development of new and refined tools. This will allow monitoring organizations to more closely approach the intent of the periodic assessment requirement and gain real value from the investment. Many monitoring organizations could greatly benefit from accessible tools that can be used to refine and improve MSA and state-scale monitoring networks. For the pollutants that are more regional in scale, appropriate tools, data, and support from the EPA Region with coordination, technical support, and waivers, when appropriate, would encourage state and regional collaboration in the implementation of efficient and regionally appropriate networks that avoid duplication and minimize overall uncertainty. We could use improved tools now in the annual planning process and should not be waiting or duplicating effort when we are approaching the 2020 assessment.

The scores and ranking of the monitors obtained through the application of the tools and guidance can only provide an indicator of areas where a more subjective evaluation may be needed. The minimum monitoring requirements are currently being met throughout the state of South Carolina. Changes suggested by this assessment will be evaluated by the Department during subsequent monitoring plans and any appropriate changes determined by the Department to meet programmatic needs will be implemented as, and if, resources are available.

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Appendix A: Risk of Future NAAQS Exceedances

This appendix contains calculations designed to predict the risk of a future NAAQS exceedance for each of the criteria pollutants based on 2009-2013 data. The purpose of this test is to see which sites are most likely to exceed the applicable NAAQS in the following three years based on previous data trends. Since 2009, all of the design values have continued to decline.

Appendix A: Risk of Future NAAQS Exceedances

Pollutant	Form	Site ID	Site Name	2009	2010	2011	2012	2013	Average	Standard Deviation	90% Upper Confidence Interval	0.8*NAAQS	Is 90% CI < 80% of NAAQS?
Ozone	8-hour	45-001-0001	Due West	72	67	62	64	60	65	5	70	60	No
		45-003-0003	Jackson	75	69	67	64	62	67	5	72	60	No
		45-007-0005	Big Creek			69	73	68	70	3	75	60	No
		45-015-0002	Bushy Park	60	62	62	64	61	62	1	63	60	No
		45-019-0046	Cape Romain	67	67	65	66	63	66	2	68	60	No
		45-021-0002	Cowpens	67	69	66	70	66	68	2	70	60	No
		45-025-0001	Chesterfield	70	68	66	65	62	66	3	69	60	No
		45-029-0002	Ashton	67	66	64	63	56	63	4	67	60	No
		45-031-0003	Pee Dee	71	70	68	70	66	69	2	71	60	No
		45-037-0001	Trenton	69	65	63	63	58	64	4	68	60	No
		45-045-	Hillcrest			68	69	67	68	1	70	60	No

Appendix A: Risk of Future NAAQS Exceedances

Pollutant	Form	Site ID	Site Name	2009	2010	2011	2012	2013	Average	Standard Deviation	90% Upper Confidence Interval	0.8*NAAQS	Is 90% CI < 80% of NAAQS?
		0016	Middle School										
		45-045-1003	Famoda Farms			67	66	63	65	2	68	60	No
		45-073-0001	Long Creek	71	69	65	64		67	3	71	60	No
		45-077-0002	Clemson	75	72	71	71	67	71	3	74	60	No
		45-079-0021	Congaree Bluff	67	65	62	61	57	62	4	66	60	No
		45-079-0007	Parklane	72	70	70		65	69	3	73	60	No
		45-079-1001	Sandhill	75	71	73	73	69	72	2	74	60	No
		45-083-0009	NSFS	78	76	74	75	72	75	2	77	60	No
		45-091-0006	York	72	67	64	65	63	66	4	70	60	No
$PM_{2.5}$	Annual	45-019-0048	FAA	9.9				8.9	9	1	13	9.6	No
		45-019-0049	Charleston Public Works	9.5	9.1	9.2	8.9	8.2	9	0	9	9.6	Yes
		45-025-0001	Chesterfield	10.9	10.3	9.7		8.4	10	1	11	9.6	No
		45-037-0001	Trenton			10.1	9.8	9.3	10	0	10	9.6	No
		45-041-	Williams			10.7	10.4	9.6	10	1	12	9.6	No

Appendix A: Risk of Future NAAQS Exceedances													
Pollutant	**Form**	**Site ID**	**Site Name**	**2009**	**2010**	**2011**	**2012**	**2013**	**Average**	**Standard Deviation**	**90% Upper Confidence Interval**	**0.8*NAAQS**	**Is 90% CI < 80% of NAAQS?**
		0003	Middle School										
		45-045-0015	Greenville ESC			11.2	10.9	10	11	1	13	9.6	No
		45-045-0016	Hillcrest Middle School					9.5	10			9.6	No
		45-063-0008	Irmo			11.3	11.1	10.3	11	1	13	9.6	No
		45-079-0007	Parklane				10.1	9.4	10	0	10	9.6	No
		45-079-0019	Bates House					10.1	10			9.6	No
		45-083-0011	T.K. Gregg				10.7	9.9	10	1	14	9.6	No
	24-Hour	45-019-0048	FAA	22				21	22	1	26	28	Yes
		45-019-0049	Charleston Public Works	22	21	22	22	20	21	1	22	28	Yes
		45-025-0001	Chesterfield	22	20	20		19	20	1	21	28	Yes
		45-037-	Trenton			21	20	20	20	1	22	28	Yes

Appendix A: Risk of Future NAAQS Exceedances													
Pollutant	**Form**	**Site ID**	**Site Name**	**2009**	**2010**	**2011**	**2012**	**2013**	**Average**	**Standard Deviation**	**90% Upper Confidence Interval**	**0.8*NAAQS**	**Is 90% CI < 80% of NAAQS?**
		0001											
		45-041-0003	Williams Middle School			23	20	20	21	2	24	28	Yes
		45-045-0015	Greenville ESC			23	23	22	23	1	25	28	Yes
		45-045-0016	Hillcrest Middle School					19	19			28	No
		45-063-0008	Irmo			24	23	22	23	1	25	28	Yes
		45-079-0007	Parklane				20	20	20	0	20	28	Yes
		45-079-0019	Bates House					22	22			28	No
		45-083-0011	T.K. Gregg				21	20	21	1	25	28	Yes
PM_{10}	24-hr (2nd	45-019-	Jenkins Ave.				47	42	45	4	63	120	Yes

Appendix A: Risk of Future NAAQS Exceedances													
Pollutant	**Form**	**Site ID**	**Site Name**	**2009**	**2010**	**2011**	**2012**	**2013**	**Average**	**Standard Deviation**	**90% Upper Confidence Interval**	**0.8*NAAQS**	**Is 90% CI < 80% of NAAQS?**
	Max)	0003	Fire Station										
		45-025-0001	Chesterfield	32	36	37	37	29	34	4	38	120	Yes
		45-043-0011	Howard High School #3			60	56	57	58	2	61	120	Yes
		45-079-0019	Bates House (USC)	47	45	43	42	37	43	4	47	120	Yes
		45-019-0003	Jenkins Ave. Fire Station				47	42	45	4	63	120	Yes
		45-019-0003	Jenkins Ave. Fire Station				47	42	45	4	63	120	Yes
CO	1-hour (2nd Max)	45-079-0007	Parklane			1.2	1.3	1	1	0	1	28	Yes
	8-hour (2nd Max)	45-079-0007	Parklane			0.8	0.8	1	1	0	1	7.2	Yes
SO_2	1-hour	45-019-	Jenkins Ave.	35	30	21	18	16	24	8	32	60	Yes

Appendix A: Risk of Future NAAQS Exceedances													
Pollutant	**Form**	**Site ID**	**Site Name**	**2009**	**2010**	**2011**	**2012**	**2013**	**Average**	**Standard Deviation**	**90% Upper Confidence Interval**	**0.8*NAAQS**	**Is 90% CI < 80% of NAAQS?**
		0003	Fire Station										
		45-019-0046	Cape Romain (VISTAS)	19	18	12	10	7	13	5	18	60	Yes
		45-045-0015	Greenville Employment Security Commission (ESC)			14	11	7	11	4	18	60	Yes
		45-063-0008	Irmo	83	80	64	55	37	64	19	82	60	No
		45-073-0001	Long Creek	14	9	6	5	5	8	4	12	60	Yes
		45-079-0007	Parklane					12	12			60	No
		45-079-0021	Congaree Bluff	48	44	33	21	17	33	14	46	60	Yes

Appendix A: Risk of Future NAAQS Exceedances													
Pollutant	**Form**	**Site ID**	**Site Name**	**2009**	**2010**	**2011**	**2012**	**2013**	**Average**	**Standard Deviation**	**90% Upper Confidence Interval**	**0.8*NAAQS**	**Is 90% CI < 80% of NAAQS?**
		45-019-0003	Jenkins Ave. Fire Station	35	30	21	18	16	24	8	32	60	Yes
		45-019-0003	Jenkins Ave. Fire Station	35	30	21	18	16	24	8	32	60	Yes
NO_2	Annual	450190003	Jenkins Ave. Fire Station	7.59	7.57	6.57	6.60	6.66	7	1	8	42	Yes
		450190046	Cape Romain (VISTAS)	1.39			1.62	1.25	1	0	1	42	Yes
		450450015	Greenville Employment Security Commission (ESC)		10.73	8.88		8.35	9	1	11	42	Yes
		450791001	Sandhill Experimental Station	5.04	5.35	5.67	4.28	4.14	5	1	6	42	Yes
	1-hour	450190003	Jenkins Ave.	40	41	38	37	36	38	2	40	60	Yes

Appendix A: Risk of Future NAAQS Exceedances													
Pollutant	**Form**	**Site ID**	**Site Name**	**2009**	**2010**	**2011**	**2012**	**2013**	**Average**	**Standard Deviation**	**90% Upper Confidence Interval**	**0.8*NAAQS**	**Is 90% CI < 80% of NAAQS?**
			Fire Station										
		450190046	Cape Romain (VISTAS)	12	12	11	11	10	11	1	12	60	Yes
		450450015	Greenville Employment Security Commission (ESC)				48	45	47	2	56	60	Yes
		450791001	Sandhill Experimental Station	40	40	40	39	37	39	1	40	60	Yes

Appendix B: Recommendations for Network Optimization

Appendix B: Recommendations for Network Optimization							
Site Name	**Site ID**	**Site Established**	**Monitor Type**	**Monitoring Objective**	**Pollutant/Method**	**Assigned Value from Assessment**	**Recommendations for Optimization**
Big Creek	45-007-0005	June 6, 2008	SLAMS	Max Ozone Concentration / Upwind Background	Ozone	Low	Even though this Site is ranked low, it will be retained.
Cowpens	45-021-0002	March 25, 1988	SPM	Upwind / Background	Ozone	Low	This Site was terminated on July 5, 2016.
Greenville ESC	45-045-0015	April 11, 2008	SLAMS	Population Exposure / Welfare Related Impacts	$PM_{2.5}$	High	No changes. This monitor partially fulfills the requirements for the MSA.
			SPM	Population Exposure	$PM_{2.5}$ Continuous	N/A	No changes. This monitor fulfills the continuous monitoring requirement for the MSA.
			SPM	Population Exposure	$PM_{2.5}$ Speciation	N/A	This sampler was terminated as part of the EPA Speciation Network Assessment in 2014.
			SLAMS	Population Exposure	PM_{10}	N/A	No changes. This monitor fulfills the PM_{10} monitoring requirements for the MSA.
			SLAMS	Population Exposure	SO_2	N/A	No changes anticipated at this time.
			SLAMS	Population Exposure	NO_2	N/A	No changes anticipated at this time.
Hillcrest Middle	45-045-0016	February 17, 2009	SLAMS	Population Exposure	Ozone	Medium	No changes are anticipated at this time. This monitor is collocated with a

Appendix B: Recommendations for Network Optimization							
Site Name	**Site ID**	**Site Established**	**Monitor Type**	**Monitoring Objective**	**Pollutant/Method**	**Assigned Value from Assessment**	**Recommendations for Optimization**
School							required $PM_{2.5}$ sampler.
			SLAMS	Population Exposure	$PM_{2.5}$	Low	No changes. This monitor partially fulfills the requirements for the MSA.
Famoda Farm	45-045-1003	August 7, 2008	SLAMS	Max Ozone Concentration	Ozone	Low	This Site was terminated on November 13, 2015.
Clemson CMS	45-077-0002	July 14, 1979	SLAMS	General Background	Ozone	Low	Due to the low assessed value of this Site and other Department monitoring needs, it is recommended that this Site be terminated.
Wolf Creek	45-077-0003	August 10, 2010	SPM	General / Background	Ozone	Low	This Site will be retained.
Long Creek	45-073-0001	August 1, 1983	SPM	General / Background	$PM_{2.5}$ Continuous	N/A	No changes are anticipated at this time.
			SPM	General / Background	Ozone	Low	
			SPM	Regional Transport	SO_2	N/A	
North Spartanburg Fire Station #2	45-083-0009	April 4, 1990	SLAMS	Max Ozone Concentration	Ozone	Medium	No changes are anticipated at this time. This Site fulfills the minimum monitoring requirements for the MSA.
T.K. Gregg Recreation Center	45-083-0011	December 29, 2008	SLAMS	Highest Concentration	$PM_{2.5}$	Medium	This Site is the required $PM_{2.5}$ SLAMS site for the MSA.
			SPM	Highest Concentration	$PM_{2.5}$ Continuous	N/A	This monitor fulfills the continuous $PM_{2.5}$ monitoring requirement for the MSA.
Irmo	45-063-0008	April 7, 1989	SLAMS	Population Exposure	$PM_{2.5}$	Low	No changes are anticipated at this time. This monitor partially fulfills the monitoring requirements for the MSA.

Appendix B: Recommendations for Network Optimization							
Site Name	**Site ID**	**Site Established**	**Monitor Type**	**Monitoring Objective**	**Pollutant/Method**	**Assigned Value from Assessment**	**Recommendations for Optimization**
			SPM	Population Exposure	$PM_{2.5}$ Continuous	N/A	No changes are anticipated at this time. This monitor fulfills the continuous monitoring requirement for the MSA.
			SPM	Source-Oriented	SO_2	N/A	No changes are anticipated at this time.
Cayce City Hall	45-063-0010	December 6, 2007	SLAMS	Population Exposure	PM_{10}	N/A	No changes are anticipated at this time.
Parklane	45-079-0007	April 3, 1980	NCore	Population Exposure	$PM_{2.5}$	Low	No changes are anticipated. Parklane is the NCore site for South Carolina.
				Population Exposure	$PM_{2.5}$ Continuous	N/A	
				Population Exposure	$PM_{2.5}$ Speciation	N/A	
				Population Exposure	$PM_{10-2.5}$	N/A	
				Max Ozone Concentration	Ozone	High	
				Population Exposure	SO_2	N/A	
				Population Exposure	CO	N/A	
				Population Exposure	NO	N/A	
				Population Exposure	NO_y	N/A	
				Population Exposure /	Lead	N/A	

Appendix B: Recommendations for Network Optimization							
Site Name	**Site ID**	**Site Established**	**Monitor Type**	**Monitoring Objective**	**Pollutant/Method**	**Assigned Value from Assessment**	**Recommendations for Optimization**
				General Background			
Bates House	45-079-0019	November 24, 1998	SLAMS	Population Exposure	$PM_{2.5}$	Low	This Site is scheduled for termination in early Spring, 2017. The PM2.5 sampler was moved to Parklane to fulfill the collocation requirement.
			QA Collocated	Quality Assurance	Collocated $PM_{2.5}$	N/A	
			SLAMS	Population Exposure	PM_{10}	N/A	
Congaree Bluff	45-079-0021	December 27, 1999	SPM	General / Background	Ozone	Medium	No changes anticipated at this time. On May 26, 2016, Scale for Ozone and Sulfur Dioxide was changed from Urban to Neighborhood to meet Site Waiver requirements.
			SPM	General / Background	SO_2	N/A	
Sandhill Experimental Station	45-079-1001	January 1, 1959	SLAMS	Max Ozone Concentration	Ozone	Low	No changes. This Site fulfills the monitoring requirements for the MSA.
			SPM	General / Background Max Precursor Emissions Impact	NO_2	N/A	No changes are anticipated at this time.
York CMS/ York County	45-091-0006/ 45-091-0008	March 30, 1993/ TBD	SLAMS	Upwind Background	Ozone	Medium	This Site was terminated on December 12, 2016 and the monitors were moved to the new York County Site (45-0091-0008). The start date was February 27, 2017.
			SPM	Upwind Background	SO_2	N/A	
Howard High School #3	45-043-0011	July, 15 2008	SPM	Population Exposure Highest Concentration	PM_{10}	N/A	No changes are anticipated at this time.

Appendix B: Recommendations for Network Optimization

Site Name	Site ID	Site Established	Monitor Type	Monitoring Objective	Pollutant/Method	Assigned Value from Assessment	Recommendations for Optimization
Jackson Middle School	45-003-0003	October 24, 1985	SLAMS	Upwind Background	Ozone	Low	No changes are anticipated at this time. This monitor provides upwind, background data supporting ozone forecasting for the CSA.
Trenton	45-037-0001	March 28, 1980	SPM	Extreme Downwind	$PM_{2.5}$	Low	No changes are anticipated at this time.
			SPM	Extreme Downwind	$PM_{2.5}$ Continuous	N/A	No changes are anticipated at this time.
			SLAMS	Max Ozone Concentration/ Extreme Downwind	Ozone	Low	No changes are anticipated at this time. This monitor does provide downwind and transport data supporting ozone forecasting for the MSA.
Bushy Park	45-015-0002	June 20, 1978	SLAMS	Max Ozone Concentration	Ozone	High-Site is heavily vegetated and may not meet Appendix E to Part 58 requirements	The monitor is being considered for relocation to better meet required monitoring and monitoring objectives for the Charleston – North Charleston MSA.
Jenkins Avenue Fire Station	45-019-0003	February 14, 1969	SLAMS	Highest Concentration	PM_{10}	N/A	No changes are anticipated at this time. This monitor currently fulfills the PM_{10} monitoring requirements for the MSA
			SPM	Population Exposure	SO_2	N/A	No changes are anticipated at this time.
			SPM	Highest Concentration,	NO_2	N/A	No changes are anticipated at this time.

Appendix B: Recommendations for Network Optimization							
Site Name	**Site ID**	**Site Established**	**Monitor Type**	**Monitoring Objective**	**Pollutant/Method**	**Assigned Value from Assessment**	**Recommendations for Optimization**
				Source Oriented			
Cape Romain	45-019-0046	July 11, 1983	SLAMS	General Background	Ozone	Medium	No changes are anticipated at this time. Cape Romain is South Carolina’s sole Class I area.
			IMPROVE	IMPROVE protocol	$PM_{2.5}$ Speciation	N/A	No changes are anticipated at this time.
			SPM	General Background	$PM_{2.5}$ Continuous	N/A	No changes are anticipated at this time.
			SPM	Source Oriented	SO_2	N/A	No changes are anticipated at this time.
			SPM	General Background	NO_2	N/A	No changes are anticipated at this time.
FAA	45-019-0048	April 9, 1999	SPM	Population Exposure	$PM_{2.5}$	High	No changes are anticipated at this time. The monitors are being considered for relocation to better meet required monitoring and monitoring objectives for the Charleston – North Charleston MSA
			QA Collocated	Population Exposure	$PM_{2.5}$ Collocated	N/A	
Charleston Public Works	45-019-0049	November 20, 1998	SLAMS	Population Exposure	$PM_{2.5}$	Medium	No changes are anticipated at this time. The monitors are being considered for relocation to better meet required monitoring and monitoring objectives for the Charleston – North Charleston MSA
			SPM	Population Exposure	$PM_{2.5}$ Continuous	N/A	
Pee Dee Experimental Station	45-031-0003	February 25, 1993	SLAMS	Max Ozone Concentration	Ozone	High	No changes are anticipated at this time. This monitor fulfills the monitoring requirements for the MSA.
Williams	45-041-0003	August 4, 2008	SLAMS	Population	$PM_{2.5}$	High	No changes are anticipated at this

Appendix B: Recommendations for Network Optimization							
Site Name	**Site ID**	**Site Established**	**Monitor Type**	**Monitoring Objective**	**Pollutant/Method**	**Assigned Value from Assessment**	**Recommendations for Optimization**
Middle School				Exposure Highest Concentration			time. This Site fulfills the monitoring requirements for the MSA.
			SPM	Population Exposure Highest Concentration	$PM_{2.5}$ Continuous	N/A	No changes are anticipated at this time. This Site fulfills the continuous $PM_{2.5}$ monitoring requirements for the MSA.
JCI Railroad	45-041-8001	January 10, 2012	SPM	Source Oriented	Lead	N/A	No changes are anticipated at this time.
JCI Entrance	45-041-8002	January 10, 2012	SPM	Source Oriented	Lead	N/A	No changes are anticipated at this time.
JCI Woods	45-041-8003	January 10,2012	SPM	Source Oriented	Lead	N/A	No changes are anticipated at this time.
Due West	45-001-0001	April 3, 1991	SLAMS	General / Background	Ozone	Low	This Site will be terminated in early 2017.
Chesterfield	45-025-0001	January 6, 2000	SLAMS	Regional Transport	$PM_{2.5}$	Low	No changes are anticipated at this time.
			SPM	Regional Transport	Continuous $PM_{2.5}$	N/A	No changes are anticipated at this time.
			CSN	Regional Transport	Speciated $PM_{2.5}$	N/A	No changes are anticipated at this time. Sampling is anticipated to continue based on availability of funding and programmatic needs.
			SPM	General / Background	PM_{10}	N/A	No changes are anticipated at this time.
			QA Collocated	General / Background	Collocated PM_{10}	N/A	No changes are anticipated at this time.
			SPM	General / Background	Ozone	Low	No changes are anticipated at this time.

Appendix B: Recommendations for Network Optimization							
Site Name	**Site ID**	**Site Established**	**Monitor Type**	**Monitoring Objective**	**Pollutant/Method**	**Assigned Value from Assessment**	**Recommendations for Optimization**
Ashton	45-029-0002	March 7, 1990	SPM	General / Background	$PM_{2.5}$ Continuous	N/A	No changes are anticipated at this time. The monitors are being considered for relocation to better meet required monitoring and monitoring objectives.
			SPM	General / Background	Ozone	Medium	

Appendix C: South Carolina 2013 Design Values

Appendix C: South Carolina 2013 Ambient Air Design Values			
Parameter	Standard	Site Name	2013 Design Value
$PM_{2.5}$ Daily	35 µg/m^3	Bates House	22
		CPW	20
		Chesterfield	19
		FAA	21
		ESC	22
		Hillcrest	19
		Irmo	22
		Parklane	20
		TK Gregg	20
		Trenton	20
		Williams	20
$PM_{2.5}$ Annual	12.0 µg/m^3	Bates House	10.1
		CPW	8.2
		Chesterfield	8.4
		FAA	8.9
		ESC	10
		Hillcrest	9.5
		Irmo	10.3
		Parklane	9.4
		TK Gregg	9.9
		Trenton	9.3
		Williams	9.6
PM_{10}	1.0 Expected Exceedance	Bates House	0
		Cayce City Hall	0
		Cayce CMS	0
		Chesterfield	0
		ESC	0
		Howard High #3	0
		Jenkins	0
O_3	0.075 ppm	Ashton	0.056
		Big Creek	0.068
		Bushy Park	0.061
		Cape Romain	0.063
		Chesterfield	0.062
		Clemson	0.067
		Congaree Bluff	0.057
		Cowpens	0.066
		Due West	0.060
		Famoda Farm	0.063
		Hillcrest	0.067
		Jackson	0.062

Appendix C: South Carolina 2013 Ambient Air Design Values			
Parameter	Standard	Site Name	2013 Design Value
		Long Creek	0.059
		NSFS #2	0.072
		Parklane	0.065
		Pee Dee	0.066
		Sandhill	0.069
		Trenton	0.058
		Wolf Creek	0.064
		York	0.063
NO_2 1-hour	100 ppb	Cape Romain	10
		ESC	45
		Jenkins	36
		Sandhill	37
NO_2 Annual	53 ppb	Cape Romain	1.25
		ESC	8.35
		Jenkins	6.66
		Sandhill	4.14
SO_2 1-hour	75 ppb	Cape Romain	7
		Congaree Bluff	17
		ESC	7
		Irmo	37
		Jenkins	16
		Long Creek	5
		Parklane	12
		York	3
CO 1-Hour	35 ppb	Parklane	1
CO 8-Hour	9 ppb	Parklane	1

Appendix D: Climate and Meteorological Analysis

The following pages describe meteorology and climate for all areas of South Carolina where ambient air monitoring exists as of January 1, 2010. Each area of the state that has monitoring is paired with a National Weather Service station and a description of the climate for each area is given followed by an analysis of windroses generated for the year, ozone monitoring season (currently, April – October) and quarterly.

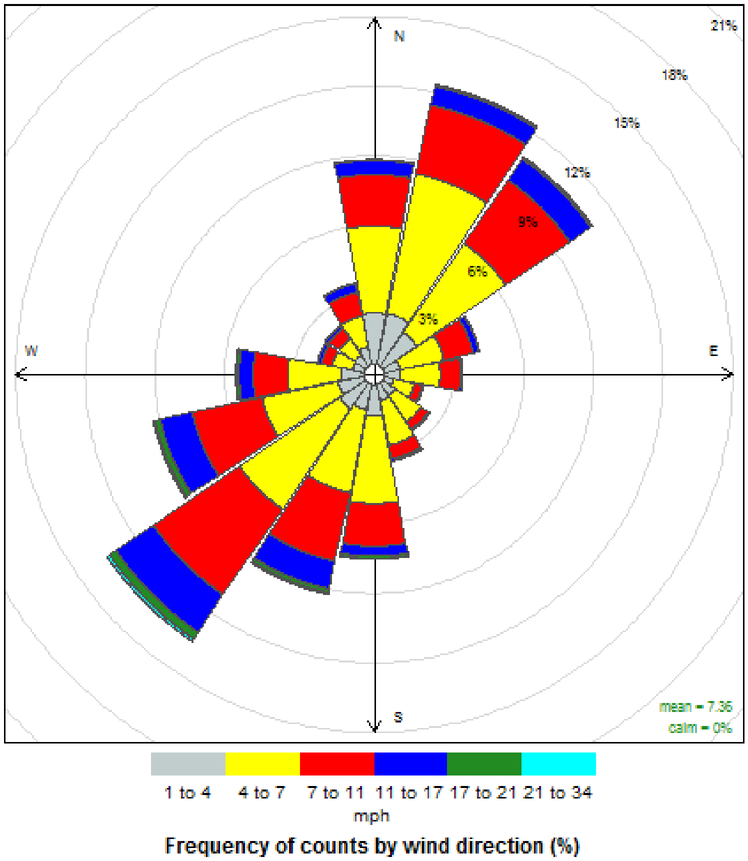
Bureau of Air Quality

South Carolina Department of Health and Environmental Control

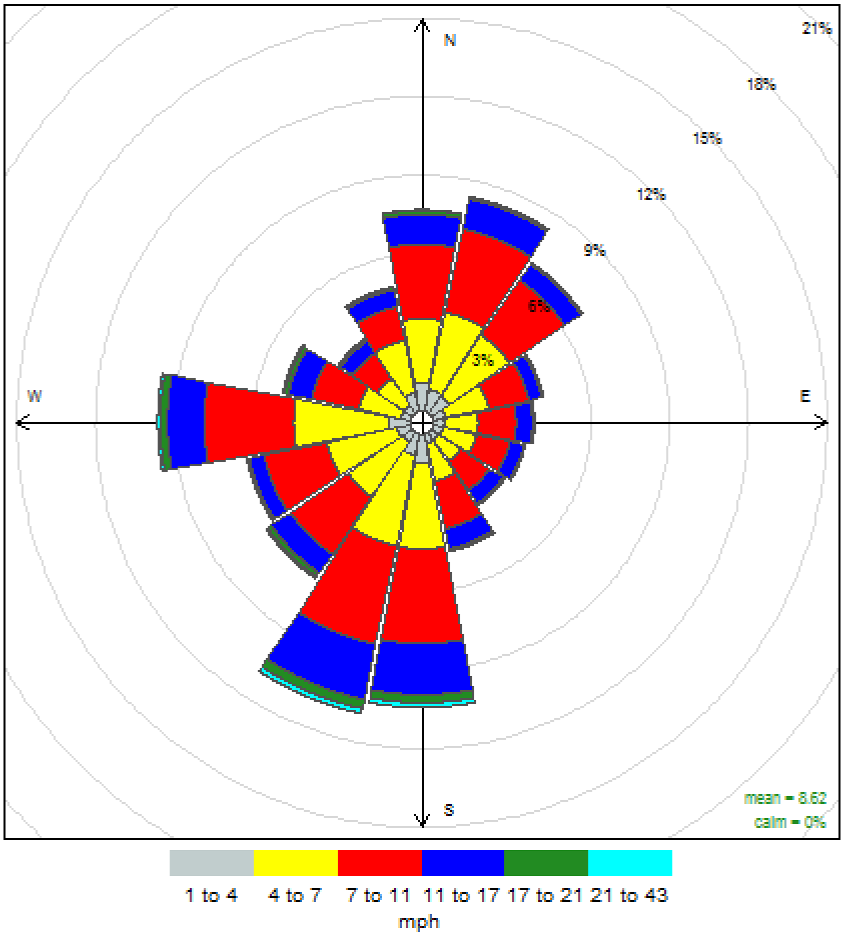
State of South Carolina: 5-Year Ambient Air Monitoring Network Assessment

July 1, 2015

Greenville-Spartanburg Annual Windrose (2009-2013)

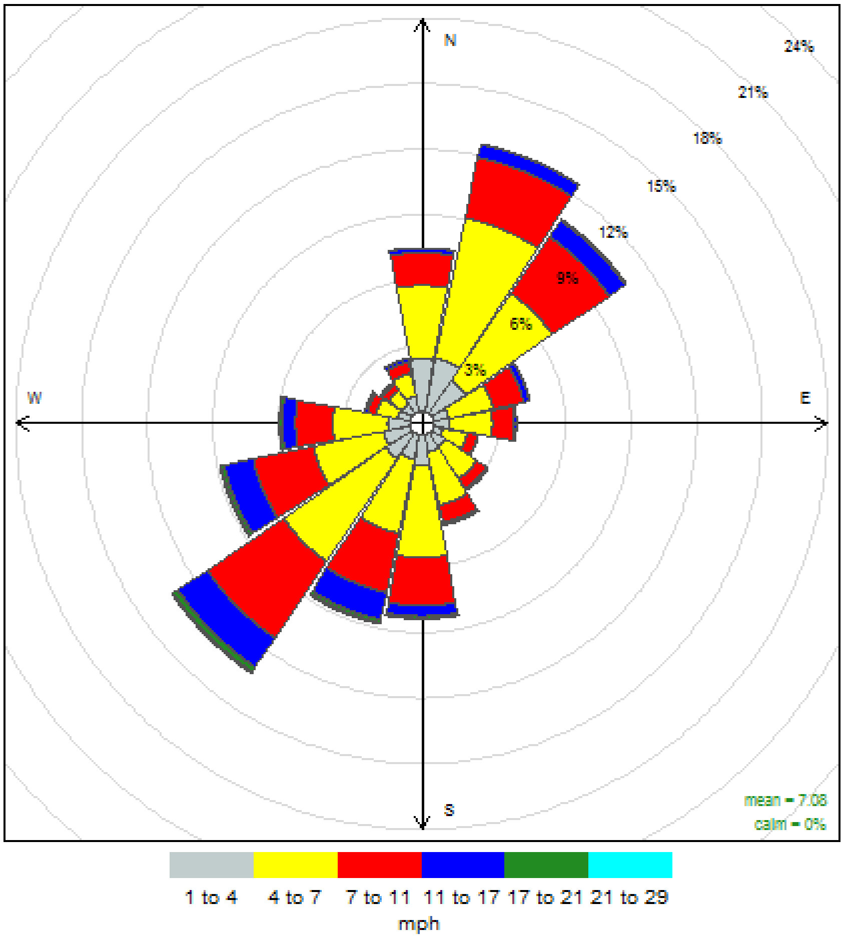


Charleston Annual Windrose (2009-2013)



Frequency of counts by wind direction (%)

Florence Ozone Season Windrose (2009-2013)



Frequency of counts by wind direction (%)

Abbeville County Meteorology and Climate

Abbeville County is located in the lower Piedmont of South Carolina, adjacent to the Georgia state line. The Abbeville County area is represented by the Greenwood County Airport station located near Greenwood, South Carolina. Greenwood is located in the west-central portion Greenwood County. Greenwood County is adjacent to Abbeville County, located to the east and southeast of Abbeville County. Abbeville County lies in between the more temperate climate to the north and west and a more subtropical climate to the south and east. Winters are generally mild with sporadic cold outbreaks which are modified by the Appalachian Mountains. Chilly, wedge scenarios are common during the cooler months when high pressure, to the north, ridges down just east of the Appalachian Mountains. This pattern results in cloudy, chilly weather with drizzle and sometimes heavier precipitation is possible when weather systems approach from the west, south, or southwest. During the summer months, the Bermuda high is normally centered out over the Atlantic with the western flank of the ridge extending into the Southeast United States. This typical summer pattern provides the area with hot and humid summers along with a chance for afternoon and evening thunderstorms. When the Bermuda high is displaced to the south and west of its normal position, hot and dry weather often develops across the lower Piedmont of South Carolina. During these summers, drought can develop across the area because the typical afternoon and evening thunderstorm activity is suppressed. Elevated ozone concentrations are generally more common during these hot and dry summers. Precipitation amounts are uniform throughout the year. Snow does not occur often dung the winter months in Abbeville County. There are many winters when no snow or ice reported. On the other hand, there are sporadic years when an ice or snow storm occurs which can cause major problems in the lower piedmont.

The Greenwood County Airport climate data is used in Tables 1, 2, and 3 to represent Abbeville County. Table 1 shows the average winter and spring maximum and minimum temperatures at the Greenwood County Airport for the climate period beginning in 1981 and ending in 2010. Table 2 shows the average summer and autumn maximum and minimum temperatures along with the average annual temperature for Abbeville County. The average seasonal and annual precipitation totals along with the average annual snowfall amount are found in Table 3.

Greenwood County Airport Climate Normals

(*Based on 1981-2010 Climate Data from NCDC)*

Table 1: Average Winter (Dec-Feb) and Spring (March-May) Temperatures for Greenwood County Airport, SC

Average Winter Maximum Temperature	Average Winter Minimum Temperature	Average Winter Temperature	Average Spring Maximum Temperature	Average Spring Minimum Temperature	Average Spring Temperature
55.4 F	33.5 F	44.4 F	73.3 F	48.8 F	61.0 F

Table 2: Average Summer (Jun-Aug) and Autumn (Sep-Nov) Temperatures Along With the Average Annual Temperature for Greenwood County Airport, SC

Average Summer Maximum Temperature	Average Summer Minimum Temperature	Average Summer Temperature	Average Autumn Maximum Temperature	Average Autumn Minimum Temperature	Average Autumn Temperature
89.5 F	67.9 F	78.7 F	74.1 F	50.5 F	62.3 F
Average Annual Temperature (based on 1981 to 2010 Climate Normals) is 61.7 F degrees.					

Table 3: Average Seasonal and Annual Precipitation Totals Along With Average Annual Snowfall Total for Greenwood County Airport, SC

Average Winter Precipitation Totals	Average Spring Precipitation Totals	Average Summer Precipitation Totals	Average Autumn Precipitation Totals	Average Annual Precipitation Totals	Abbeville Average Annual Snowfall Totals
11.70 in	10.47 in	12.09 in	10.46 in	44.72 in	1.1 in

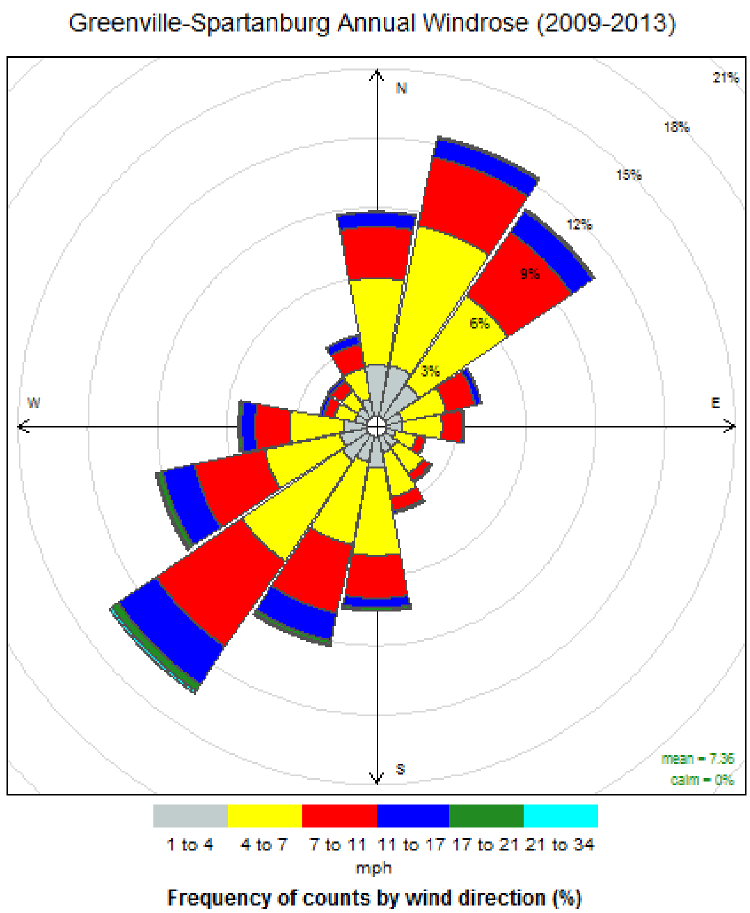
Seasonal and Annual Wind Patterns Across the Abbeville County MSA Using the Greenwood County Airport Wind Data

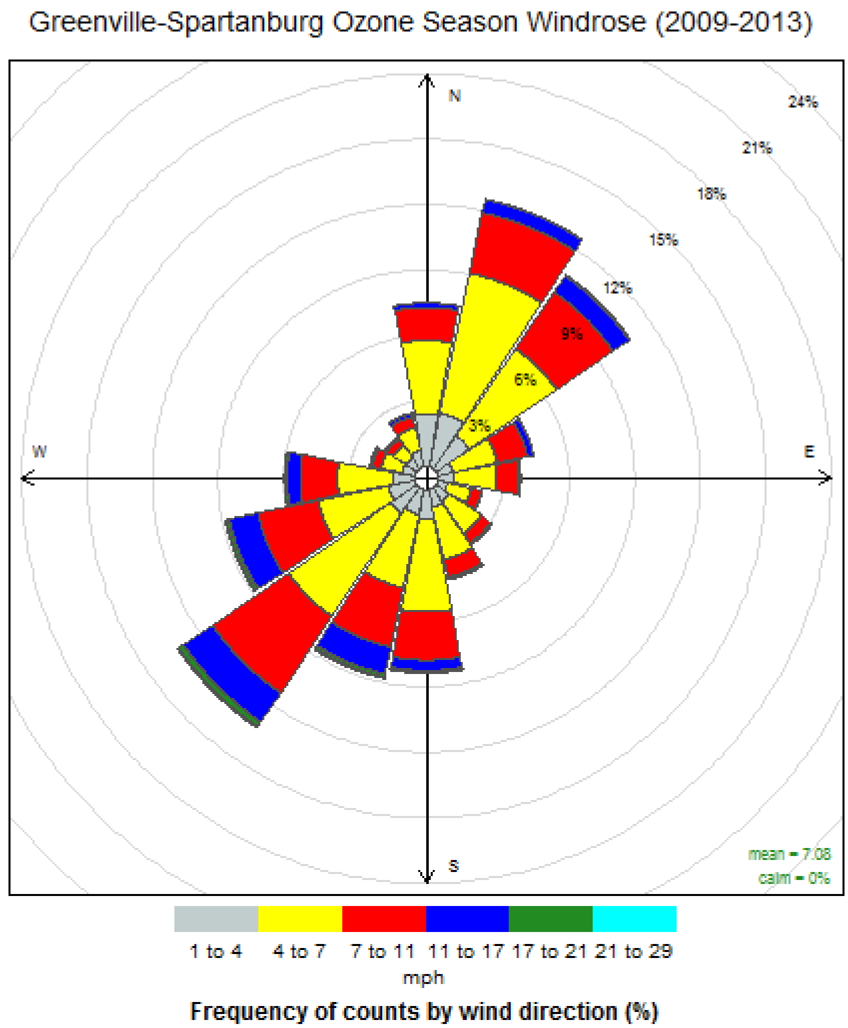
Using the Greenville-Spartanburg National Weather Service Data, a series of windroses was developed for the lower Piedmont of South Carolina. The annual windrose represents wind patterns across the lower Piedmont throughout the entire year. On an annual basis, the dominant wind directions are from the southwest, west, west-southwest and from the northeast. Wind directions that are least common include south-southeast winds, southeast, east-southeast, easterly, northwesterly, and north-northwesterly winds. The average wind speed for an entire year is 7.36 mph.

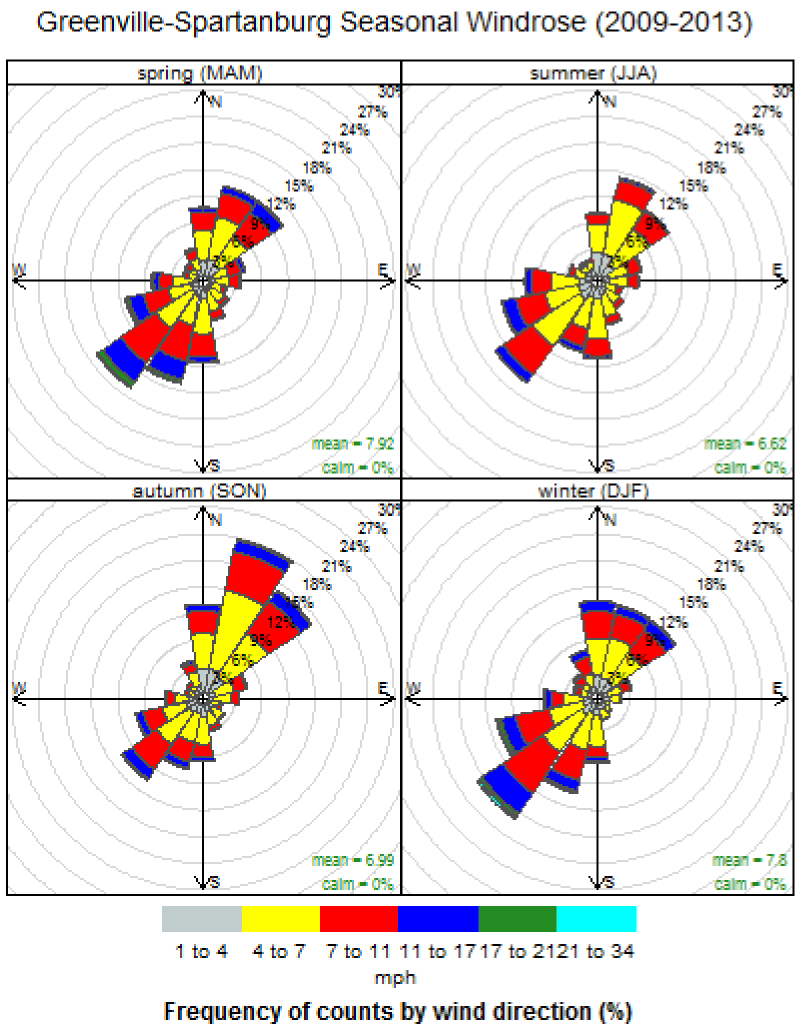
The second windrose represents the wind patterns during ozone season. Ozone season runs from April through October across Abbeville County. Wind patterns during the ozone season look very similar to the annual wind rose. Average wind speeds for the ozone season windrose are 7.08 mph.

The next four wind roses are broken up into the four quarters that make up one year. March through May represents the first quarter, June through August represents the second quarter, the third quarter includes September through November, and the fourth quarter runs from December through February. The first quarter windroses indicates that a southwesterly and northeasterly wind direction are most common. Average wind speeds during the first quarter are 7.92 mph. The second quarter wind rose (summer season) is similar to the first quarter wind rose; however, there is another secondary dominant wind direction out of the west-southwest. Average wind speeds during the second quarter period is 6.62 mph. The third quarter windrose shows a great departure from the annual, first quarter, and second quarter wind roses. During the autumn months, the wind rose indicates a dominant flow out of the northeast and north-northeast. Average wind speeds during this period are 6.99 mph. The fourth quarter windrose shows winds from the southwest, west-southwest, north, north-northeasterly, occur more frequently than any other wind directions. Average wind speeds during the fourth quarter are 7.80 mph.

Annual & Seasonal Wind Roses for the Abbeville County MSA Using the Greenwood County Wind Data




Greenville-Spartanburg Ozone Season Windrose (2009-2013)
N
E
S
W
24%
21%
18%
15%
12%
9%
6%
3%
mean = 7.08
calm = 0%
1 to 4
4 to 7
7 to 11
11 to 17
17 to 21
21 to 29
mph
Frequency of counts by wind direction (%)



Greenville-Spartanburg Seasonal Windrose (2009-2013)
spring (MAM)
summer (JJA)
autumn (SON)
winter (DJF)
N
E
S
W
mean = 7.92
calm = 0%
mean = 6.62
calm = 0%
mean = 6.99
calm = 0%
mean = 7.8
calm = 0%
1 to 4
4 to 7
7 to 11
11 to 17
17 to 21
21 to 34
mph
Frequency of counts by wind direction (%)

Anderson MSA Meteorology and Climate

The Anderson area is located just south and east of the Appalachian Mountains, near the Georgia border. This area is frequently referred to as the Upstate of South Carolina. Anderson County area's elevation above sea level is significantly higher than is the midlands of South Carolina. The Anderson County area is represented by the National Weather Service office station known as Greer. Greer is located almost half way between the cities of Greenville and Spartanburg. Meteorological conditions are a bit more temperate here than the more subtropical conditions across the midlands and inland, coastal plains. Occasional cold spells can affect the area during the winter months; however, these cold spells are modified by the Appalachian Mountains located just north and west of the Anderson area. Chilly, wedge scenarios are common during the cooler months when high pressure, to the north, ridges down just east of the Appalachian Mountains. This pattern results in cloudy, chilly weather with drizzle and sometimes heavier precipitation possible when weather systems approach from the west or southwest. Summers in the Anderson area are noticeably milder than the summers across the Midlands of South Carolina. During the summer months, when the Bermuda high is centered close to the climatology, very warm weather is common across the Upstate with afternoon thunderstorms possible from time to time. When the Bermuda high is displaced to the south and west of its normal position, hot and dry conditions often develop across the Upstate with little chances for afternoon thunderstorm activity. During these summers, drought can develop across the Upstate of South Carolina. Elevated ozone concentrations are generally more common during these hot and dry summers. Precipitation amounts are uniform throughout the year. Snow does not occur often during the winter months across the Anderson MSA; however, it's not uncommon to have one ice or snow event every year or two across the area.

The Anderson County Airport climate data is used in Tables 1, 2, and 3 to represent the Anderson MSA. Table 1 shows the average winter and spring maximum and minimum temperatures at the Anderson County airport for the climate period beginning in 1981 and ending in 2010. Table 2 shows the average summer and autumn maximum and minimum temperatures along with the average annual temperature for the Anderson County Airport. The average seasonal and annual Precipitation totals along with the average annual snowfall amounts are found in Table 3.

Anderson County Airport Climate Normals

(*Based on 1981-2010 Climate Data from NCDC)*

Table 1: The Average Winter (Dec-Feb) and Spring (March-May) Temperatures for the Anderson County Airport Site, SC

Average Winter Maximum Temperature	Average Winter Minimum Temperature	Average Winter Temperature	Average Spring Maximum Temperature	Average Spring Minimum Temperature	Average Spring Temperature
53.8 F	33.3 F	43.6 F	72.2 F	48.8 F	60.5 F

Table 2: The Average Summer (Jun-Aug) and Autumn (Sep-Nov) Temperatures Along With the Average Annual Temperature for the Anderson County Airport Site, SC

Average Summer Maximum Temperature	Average Summer Minimum Temperature	Average Summer Temperature	Average Autumn Maximum Temperature	Average Autumn Minimum Temperature	Average Autumn Temperature
88.3 F	67.9 F	78.1 F	72.5 F	51.1 F	61.8 F
Average Annual Temperature (based on 1981 to 2010 Climate Normals) is 61.1 F degrees					

Table 3: The Average Seasonal and Annual Precipitation Totals, Along With the Average Annual Snowfall Totals for the Anderson County Airport Site, SC

Average Winter Precipitation Totals	Average Spring Precipitation Totals	Average Summer Precipitation Totals	Average Autumn Precipitation Totals	Average Annual Precipitation Totals	Average Annual Snowfall Totals
11.86 in	10.64 in	11.17 in	10.54 in	44.21 in	3.0 in

Seasonal and Annual Wind Patterns Across the Anderson MSA (Greenville-Spartanburg National Weather Service Wind Data)

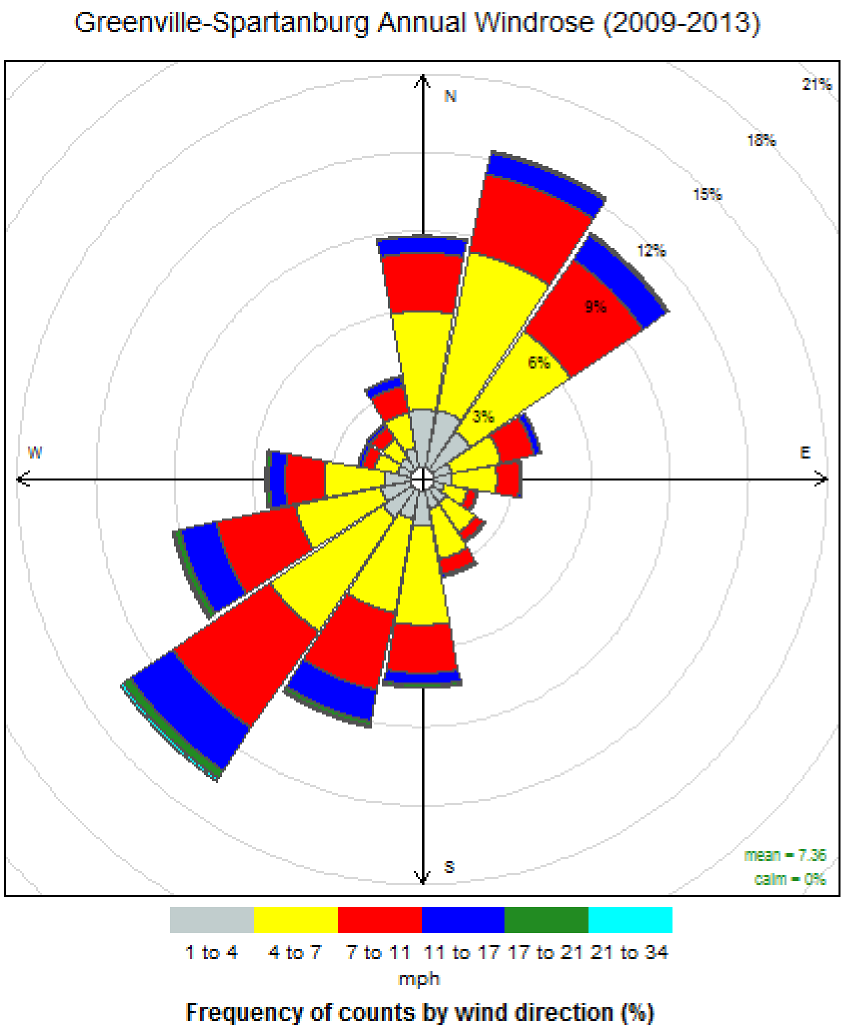
Using the Greenville-Spartanburg National Weather Service Data, a series of windroses was developed for the lower Piedmont of South Carolina. The annual windrose represents wind patterns across the lower Piedmont throughout the entire year. On an annual basis, the dominant wind directions are from the southwest, west, west-southwest and from the northeast. Wind directions that are least common include south-southeast winds, southeast, east-southeast, easterly, northwesterly, and north-northwesterly winds. The average wind speed for an entire year is 7.36 mph.

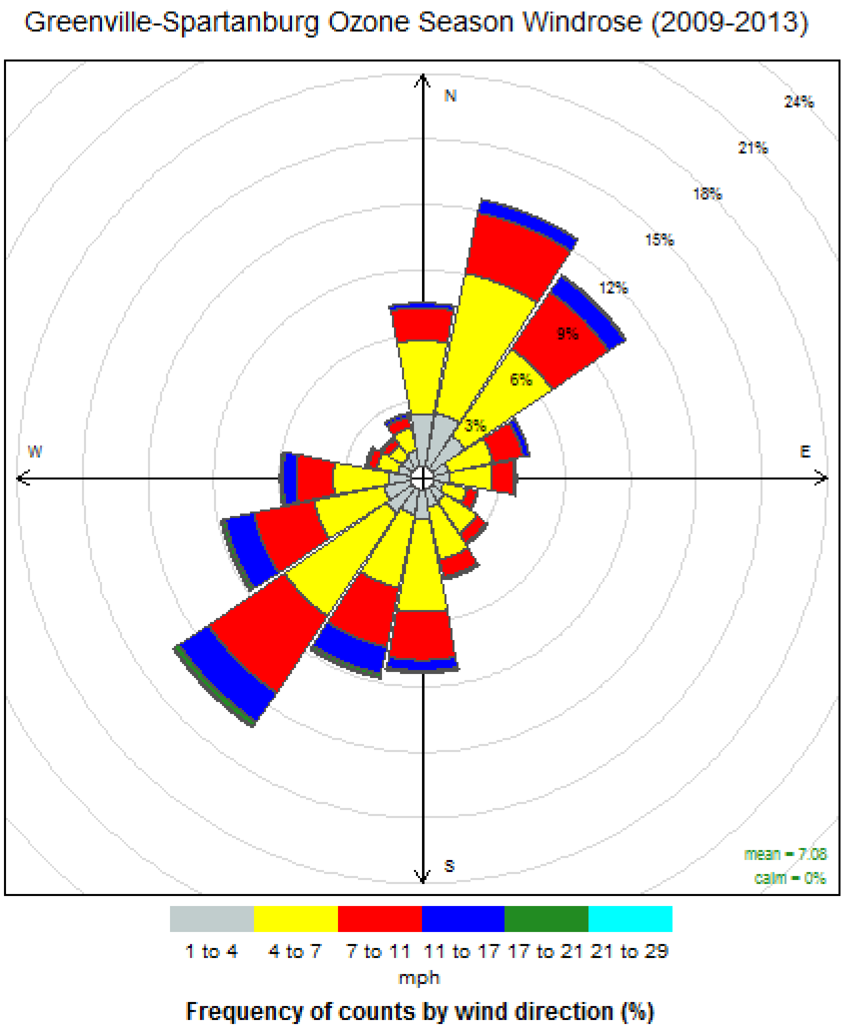
The second windrose represents the wind patterns during ozone season. Ozone season runs from April through October across Abbeville County. Wind patterns during the ozone season look very similar to the annual wind rose. Average wind speeds for the ozone season windrose are 7.08 mph.

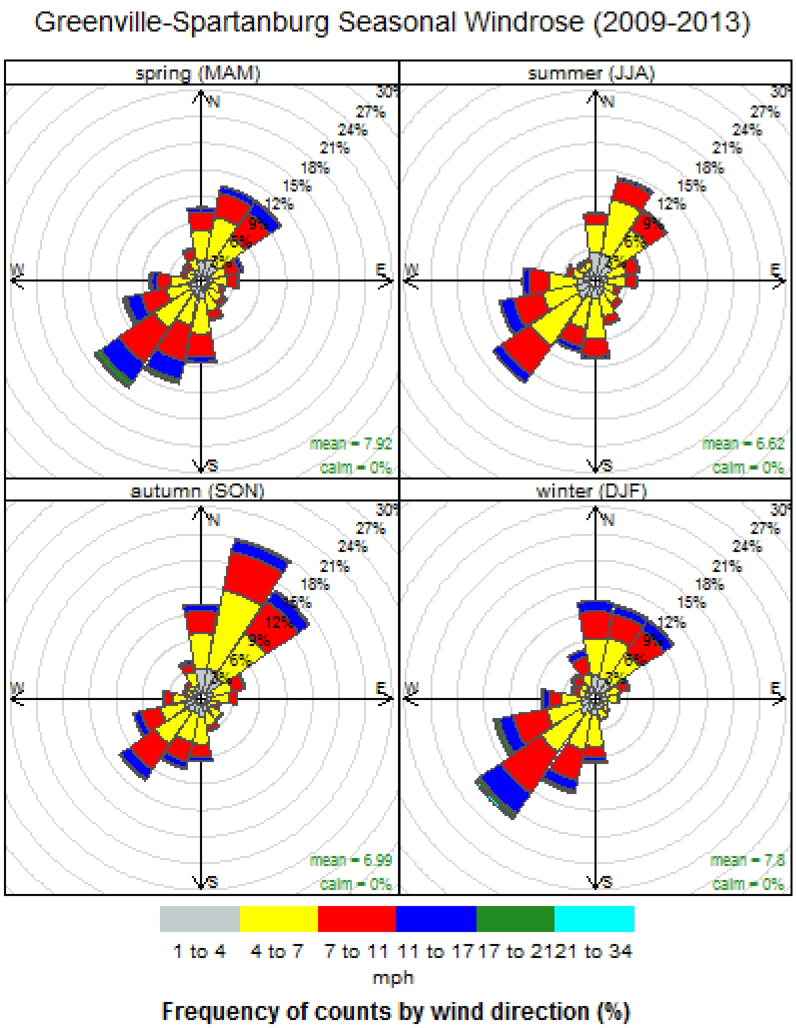
The next four wind roses are broken up into the four quarters that make up one year. March through May represents the first quarter, June through August represents the second quarter, the third quarter includes September through November, and the fourth quarter runs from December through February. The first quarter windroses indicates that a southwesterly and northeasterly wind directions are most common. Average wind speeds during the first quarter are 7.92 mph. The second quarter wind rose (summer season) is similar to the first quarter wind rose; however, there is another secondary dominant wind direction out of the west-southwest. Average wind speeds during the second quarter period is 6.62 mph. The third quarter windrose shows a great departure from the annual, first quarter, and second quarter wind roses. During the autumn months, the wind rose indicates a dominant flow out of the northeast and north-northeast. Average wind speeds during this period are 6.99 mph.

The fourth quarter windrose shows winds from the southwest, west-southwest, north, north-northeasterly, occur more frequently than any other wind directions. Average wind speeds during the fourth quarter are 7.80 mph.

<u>Annual & Seasonal Wind Roses for the Anderson MSA Using the Greenville-Spartanburg Airport National Weather Service Wind Data</u>




Greenville-Spartanburg Ozone Season Windrose (2009-2013)
N
S
E
W
3%
6%
9%
12%
15%
18%
21%
24%
mean = 7.08
calm = 0%
1 to 4
4 to 7
7 to 11
11 to 17
17 to 21
21 to 29
mph
Frequency of counts by wind direction (%)


Greenville-Spartanburg Seasonal Windrose (2009-2013)
spring (MAM)
summer (JJA)
autumn (SON)
winter (DJF)
N
E
S
W
mean = 7.92
calm = 0%
mean = 6.62
calm = 0%
mean = 6.99
calm = 0%
mean = 7.8
calm = 0%
1 to 4
4 to 7
7 to 11
11 to 17
17 to 21
21 to 34
mph
Frequency of counts by wind direction (%)

Augusta-Richmond County MSA Meteorology and Climate

The eastern portion of the Augusta-Richmond MSA extends into the west–central part of South Carolina. This area is often referred to at the Central Savannah River area. The most representative meteorological data for the central Savannah River of South Carolina is just over the border in Georgia at the Augusta National Weather Service Office. The Central Savannah River area of South Carolina has sporadic cold outbreaks during the winter months; however, the Appalachian Mountains to the west and north block the coldest of air masses from invading the west-central portion of the state. For this reason, the Central Savannah River area stays relatively mild during most of the winter months when compared to other sections of the Southeast. The terrain and the location away from the ocean results in little relief from the summer heat that is common during the summer months. Hot weather along with scattered afternoon and evening thunderstorms are the norm across the Central Savannah River area for three to four months out of the year. Rainfall can be quite variable during the summer months, and this variability is associated with the strength and position of the Bermuda high. During a normal summer, the Bermuda high is centered well out into the Atlantic with its western flank extending into the Southeastern United States. This normal position of the Bermuda high keeps a moist and unstable, southwesterly flow across South Carolina during the summer. With day time heating, scattered afternoon and evening thunderstorms occur. In some years, the Bermuda high is centered south and west of its normal position, which cuts off the Gulf of Mexico and results in subsidence across the Southeast. This pattern results in fair weather with very hot temperatures. The normal scattered afternoon and evening thunderstorm activity is suppressed, and this pattern is very favorable for droughts across much of the Southeast, including South Carolina. During these very hot and dry summers, ozone levels can rise to above normal levels, resulting in some exceedances across the region. Precipitation amounts are fairly uniform throughout the year with the highest amounts of rainfall occurring during the summer months from scattered afternoon and evening thunderstorms. Snow is rare during the winter months across the Central Savannah River area. Snow and ice does not occur during most winters in the Augusta area. For the Augusta area, two different locations were used for the climate normals.

The official site for the Augusta area is located at Augusta Bush Field. The Augusta Bush Field Airport climate data is used in Tables 1, 2, and 3 to represent the Augusta-Richmond County MSA. Table 1 shows the average winter and spring maximum and minimum temperatures at Augusta Bush Field Airport for the climate period beginning in 1981 and ending in 2010. Table 2 shows the average summer and autumn maximum and minimum temperatures along with the average annual temperature for the Augusta Bush Field Airport. The average seasonal and annual total precipitation totals along with the average annual snowfall amounts are found in Table 3.

Augusta Bush Field Airport Climate Normals

(*Based on 1981-2010 Climate Data from NCDC)*

Table 1: The Average Winter (Dec-Feb) and Spring (March-May) Temperatures Along With the Average Annual Temperature for Augusta (Bush Field), GA

Average Winter Maximum Temperature	Average Winter Minimum Temperature	Average Winter Temperature	Average Spring Maximum Temperature	Average Spring Minimum Temperature	Average Spring Temperature
60.0 F	34.3 F	47.2 F	77.4 F	49.2 F	63.3 F

Table 2: The Average Summer (Jun-Aug) and Autumn (Sep-Nov) Temperatures Along With the Average Annual Temperature for Augusta (Bush Field), GA

Average Summer Maximum Temperature	Average Summer Minimum Temperature	Average Summer Temperature	Average Autumn Maximum Temperature	Average Autumn Minimum Temperature	Average Autumn Temperature
92.1 F	68.4 F	80.2 F	77.8 F	51.7 F	64.7 F
Average Annual Temperature (based on 1981 to 2010 Climate Normals) is 63.9 F degrees.					

Table 3: The Average Seasonal and Annual Total Precipitation Amounts Along With the Average Annual Snowfall Total for the Augusta Bush Field Site

Average Winter Precipitation Totals	Average Spring Precipitation Totals	Average Summer Precipitation Totals	Average Autumn Precipitation Totals	Average Annual Precipitation Totals	Average Annual Snowfall Totals
11.22 in	9.67 in	13.37 in	9.31 in	43.57 in	0.9 in

There is a second meteorological station located at Augusta Daniel Field. Unlike, Augusta Bush Field, Augusta Daniel Field is not located near a River Valley. The river valley affects overnight low temperatures, especially during the cooler months. On clear nights with calm winds, colder air tends to drain into the Bush River Valley. The Augusta Daniel Field station has cooler day time maximum temperatures with warmer minimum temperatures than the Augusta Bush Field Site due to topography and other factors. The official site for the Augusta area is located at Augusta Bush Field. The Augusta Bush field Airport climate data is used in Tables 1, 2, and 3 to represent the Augusta-Richmond County MSA. Table 1 shows the average winter and spring maximum and minimum temperatures at Augusta Daniel Field Airport for the climate period beginning in 1981 and ending in 2010. Table 2 shows the average summer and autumn maximum and minimum temperatures along with the average annual temperature for the Augusta Daniel Field Airport. The average seasonal and annual total precipitation totals along with the average annual snowfall amounts are found in Table 3.

Augusta Daniel Field Airport Climate Normals

(*Based on 1981-2010 Climate Data from NCDC)*

Table 1: The Average Winter (Dec-Feb) and Spring (March-May) Temperatures for Augusta (Daniel Field), GA

Average Winter Maximum Temperature	Average Winter Minimum Temperature	Average Winter Temperature	Average Spring Maximum Temperature	Average Spring Minimum Temperature	Average Spring Temperature
58.1 F	39.2 F	48.7 F	75.7 F	54.2 F	65.0 F

Table 2: The Average Summer (Jun-Aug) and Autumn (Sep-Nov) Temperatures for Augusta (Daniel Field), GA Along With the Average Annual Temperature for Augusta (Daniel Field), GA

Average Summer Maximum Temperature	Average Summer Minimum Temperature	Average Summer Temperature	Average Autumn Maximum Temperature	Average Autumn Minimum Temperature	Average Autumn Temperature
90.3 F	71.2 F	80.8 F	75.9 F	56.5 F	66.2 F
Average Annual Temperature (based on 1981 to 2010 Climate Normals) is 65.2 F degrees.					

Table 3:The Average Seasonal and Annual Precipitation Totals for Augusta (Daniel Field), GA. Along With the Average Annual Snowfall Total for Augusta (Daniel Field), GA

Average Winter Precipitation Totals	Average Spring Precipitation Totals	Average Summer Precipitation Totals	Average Autumn Precipitation Totals	Average Annual Precipitation Totals	Average Annual Snowfall Totals
11.86 in	10.44 in	14.48 in	9.77 in	46.55 in	0.9 in

Seasonal and Annual Wind Patterns Across the Augusta MSA

Since the Augusta area and much of the central Savannah River area is in a river valley, the wind directions are frequently skewed resulting in a more northerly or southerly component than otherwise would be. Wind data was used from the Augusta-Bush Field National Weather Service Office to create the annual, ozone season, and quarterly wind roses. Wind speeds are generally less near the Augusta area, and many more calms are likely than some of the other weather stations due to the adjacent river valley. The first windrose created for the central Savannah River area shows the annual wind pattern and speeds that occur on a yearly basis. On an annual basis, the dominant wind directions are from the west, north, and from the south. The westerly component is more dominant through at the Augusta-Bush field site during the winter months. The northerly and southerly components are mostly likely due to the adjacent Savannah River which stretches northwest to southeast, creating a natural barrier between South Carolina and Georgia. The average annual wind speed at the Augusta site is 7.66 mph.

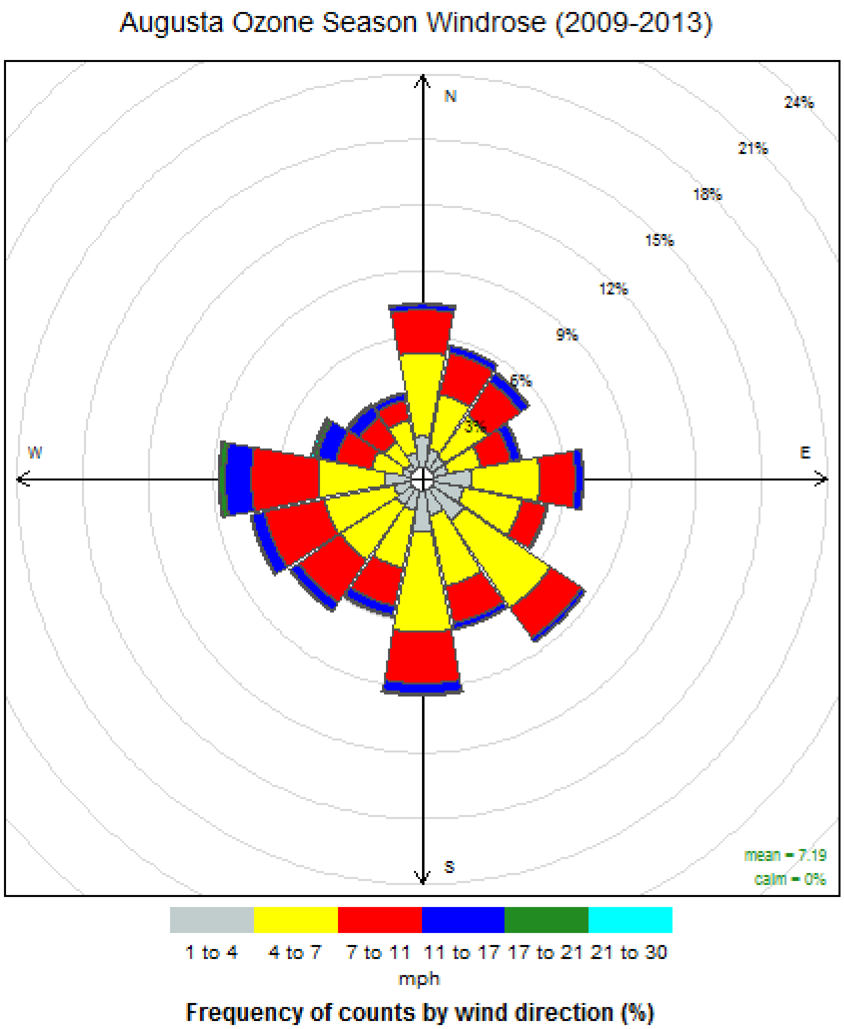
The ozone season windrose looks a great deal like the annual windrose; except for the fact the three wind directions listed above are not quite as dominant during this period. The most dominant wind directions during ozone season are westerly, northerly, easterly, southeasterly, and southerly. Westerly wind directions can frequently transport ozone pre-cursors into the

Central Savannah River area from the Atlanta metro area. Average wind speeds during ozone season are 7.19 mph.

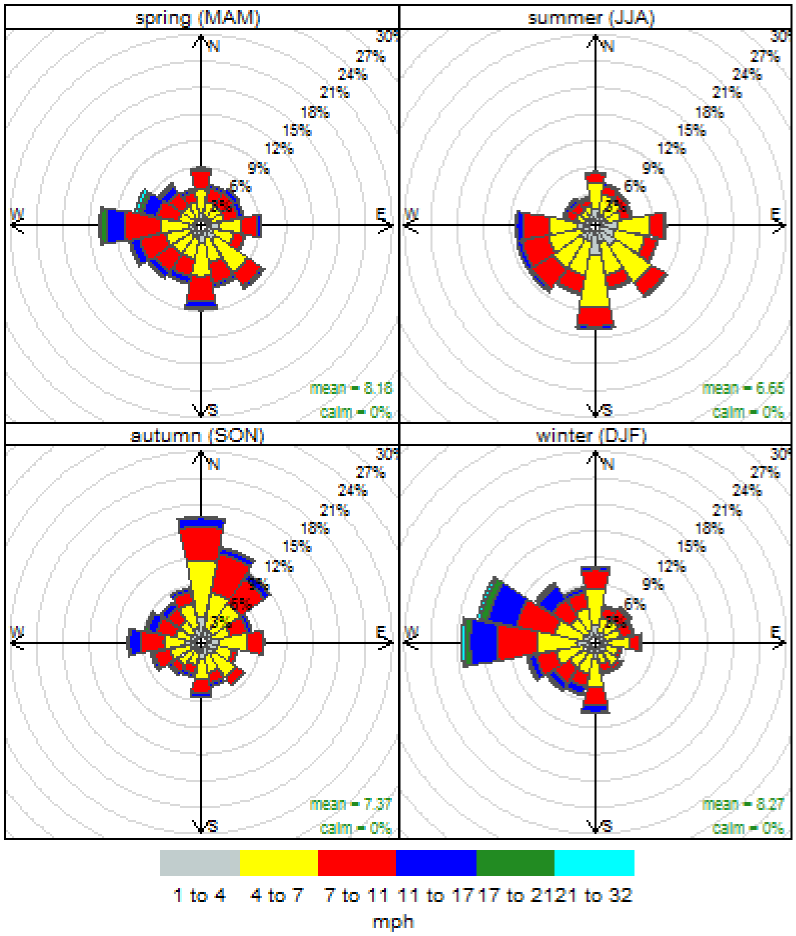
The next four windroses are broken up in quarters. The first quarterly windrose runs from March through May, the second quarterly windrose runs from June through August, the third quarterly wind rose runs from September through November, and the fourth quarterly windrose runs from December through February. The first quarter windrose for the Central Savannah River area shows that the most dominant wind directions are from the west, west-southwest, southeast, and southerly directions. Average wind speeds during the first quarter are 8.18 mph. The second quarter windrose indicates that the most dominant wind directions are from the west, west-southwest, southwest, south, and southeast. The average wind speed during the second quarter is 6.65 mph. During the third quarter, the dominant wind directions across the Central Savannah River area are from the north, the north-northeast, and the northeast. Average wind speeds during the third quarter are only 7.37 mph.

The fourth quarter windrose indicates that the most dominant winds originate from west, west-northwest, and from the northwest. The average wind speed during the fourth quarter is 8.27 mph.

Annual & Seasonal Wind Roses for the Augusta-Richmond MSA Using the Augusta Bush Field Wind Data



Augusta Seasonal Windrose (2009-2013)



Frequency of counts by wind direction (%)

Charleston-North Charleston MSA Meteorology and Climate

It should be noted that most pollutant concentrations are generally lower in the Charleston County area than in other parts of South Carolina. This is primarily due to the sea breeze which pushes inland during the warmer months. In many instances, this meteorological phenomenon cleans out the air in coastal counties of South Carolina. As a result, the air quality is good across Charleston County much of the time. Charleston’s climate is marine, subtropical with mild winters and hot/ very humid summers. During the winter months, cold air masses are modified significantly, having a hard time passing across the Appalachian Mountains. In addition, the close proximity of the Gulf Stream helps to modify cold air masses. Hard freezes are rare in the city of Charleston and along the immediate coast. During a normal summer, the Bermuda high pressure’s western flank covers the Southeastern United States. This pumps in a very warm, moist, and unstable air mass across the Southeast, resulting in scattered afternoon and evening thunderstorms across coastal South Carolina. During the warmer months, a pressure gradient develops between the ocean and the land. The cooler water temperatures and warmer land temperatures result in lower pressure across the land with higher pressure just above the ocean. This sets up a pressure gradient which causes winds to blow from the ocean to the land. As a result, the sea breeze develops during the warmer months. As a result, winds blow from the oceans (from the south) northward across the land. This ocean to land breeze (the sea breeze) results in cleaner air across the coastal counties of South Carolina. During some summers, the Bermuda high is centered south and west of its normal position, cutting off Gulf moisture and resulting in hot/humid and dry summers across the coastal counties. When this occurs, the normal scattered afternoon and evening thunderstorm activity is suppressed, and much of the area may experience drought. The low country of South Carolina receives most of its rainfall during the summer months with hot and humid conditions combining with the sea breeze front to produce locally heavy rainfall amounts associated with afternoon and evening thunderstorms. Snow and ice are extremely rare in the Charleston area. Snow or ice mainly only occur every ten or fifteen years or so and when it does occur, it is generally light.

The Charleston Airport climate data is used in Tables 1, 2, and 3 to represent the Charleston MSA. Table 1 shows the average winter and spring maximum and minimum temperatures at the Charleston MSA for the climate period beginning in 1981 and ending in 2010. Table 2 shows the average summer and autumn maximum and minimum temperature along with the average annual temperature for the Charleston MSA. The average seasonal and annual precipitation totals at the Charleston Airport meteorological Station along with the average annual snowfall amounts are found in Table 3.

Charleston International Airport, SC Climate Normals

(*Based on 1981-2010 Climate Data from NCDC)*

Table 1: The Average Winter (Dec-Feb) and Spring (March-May) Temperatures for the Charleston, SC Airport

Average Winter Maximum Temperature	Average Winter Minimum Temperature	Average Winter Temperature	Average Spring Maximum Temperature	Average Spring Minimum Temperature	Average Spring Temperature
61.1 F	39.4 F	50.2 F	76.4 F	53.9 F	65.2 F

Table 2: The Average Summer (Jun-Aug) and Autumn (Sep-Nov) Temperatures Along With the Average Annual Temperature for the Charleston, SC irport

Average Summer Maximum Temperature	Average Summer Minimum Temperature	Average Summer Temperature	Average Autumn Maximum Temperature	Average Autumn Minimum Temperature	Average Autumn Temperature
89.7 F	71.7 F	80.7 F	77.3 F	57.1 F	67.2 F
Average Annual Temperature (based on 1981 to 2010 Climate Normals) is 65.9 F degrees.					

Table 3: The Average Seasonal and Annual Precipitation Totals Along With the Average Annual Snowfall Total for the Charleston, SC Airport

Average Winter Precipitation Totals	Average Spring Precipitation Totals	Average Summer Precipitation Totals	Average Autumn Precipitation Totals	Average Annual Precipitation Totals	Average Annual Snowfall Totals
9.78 in	9.64 in	19.33 in	12.28 in	51.03 in	0.5 in

The Charleston City climate data is used in Tables 1, 2, and 3 to represent downtown Charleston. Table 1 shows the average winter and spring maximum and minimum temperatures in downtown Charleston for the climate period beginning in 1981 and ending in 2010. Table 2 shows the average summer and autumn maximum and minimum temperature along with the average annual temperature for downtown Charleston. The average seasonal and annual total amounts of precipitation at the Charleston City meteorological Station along with the average annual snowfall amounts are found in Table 3.

<u>Charleston City Climate Normals</u>

(*Based on 1981-2010 Climate Data from NCDC)*

Table 1: The Average Winter (Dec-Feb) and Spring (March-May) Temperatures for the City of Charleston

Average Winter Maximum Temperature	Average Winter Minimum Temperature	Average Winter Temperature	Average Spring Maximum Temperature	Average Spring Minimum Temperature	Average Spring Temperature
58.6 F	44.6 F	51.6 F	71.9 F	59.2 F	65.5 F

Table 2: The Average Summer (Jun-Aug) and Autumn (Sep-Nov) Temperatures Along With the Average Annual Temperature for the City of Charleston

Average Summer Maximum Temperature	Average Summer Minimum Temperature	Average Summer Temperature	Average Autumn Maximum Temperature	Average Autumn Minimum Temperature	Average Autumn Temperature
86.2	75.7 F	80.9 F	74.6 F	62.7 F	68.6 F
Average Annual Temperature (based on 1981 to 2010 Climate Normals) is 66.7 F degrees.					

Table 3: The Average Seasonal and Annual Precipitation Totals Along With the Average Annual Snowfall Total for the City of Charleston

Average Winter Precipitation Totals	Average Spring Precipitation Totals	Average Summer Precipitation Totals	Average Autumn Precipitation Totals	Average Annual Precipitation Totals	Average Annual Snowfall Totals
8.05 in	7.99 in	16.76 in	11.62 in	44.42 in	Trace

Seasonal and Annual Wind Patterns Across the Charleston MSA

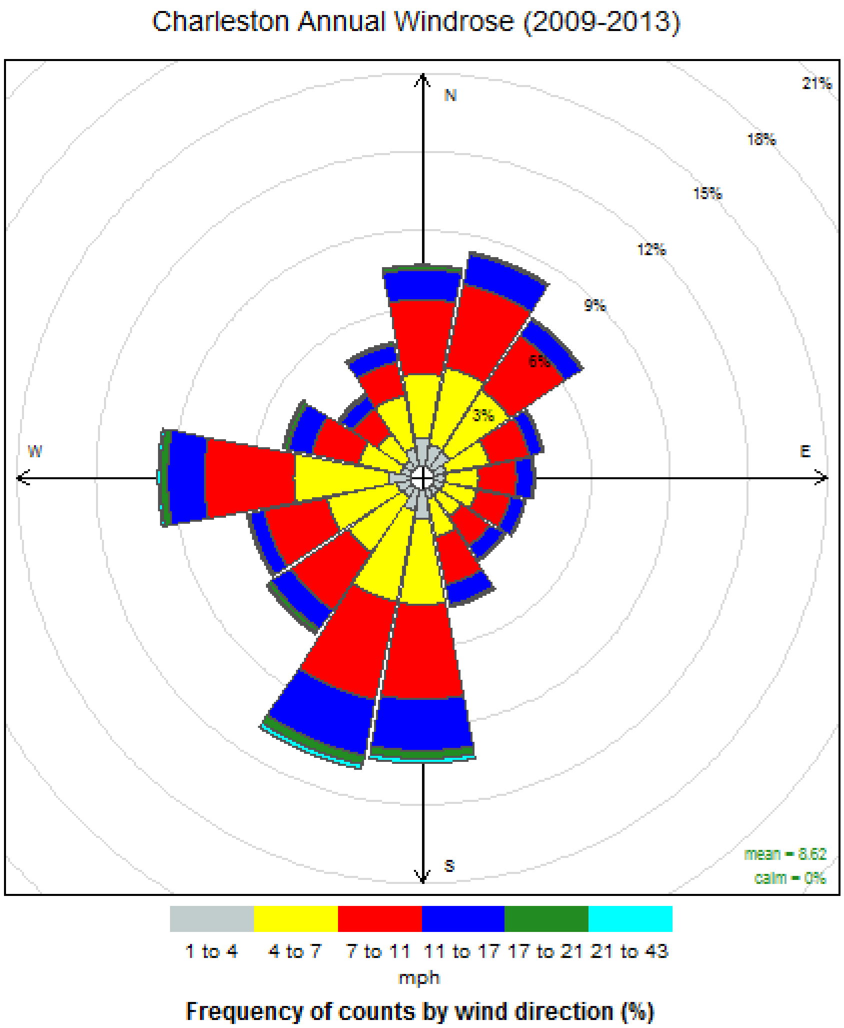
The windroses depict the five year average wind direction and wind speeds at the Charleston airport. The 2009-2013 annual windrose for Charleston shows five dominant transport regimes. The annual wind rose indicates that winds most often come from a south, south-southwest, west, north, and north-northeast direction. The average annual wind speed for the Charleston area is 8.62 mph.

A windrose was also created for ozone season which runs from April through October. During the ozone season, the windrose shows that the most dominant wind directions are from the south and south-southwest. This southerly wind direction is the result of the sea breeze that develops during the warm months across the coastal areas of South Carolina. As the sea breeze pushes inland, a southerly flow off the ocean develops, and this generally keeps ozone levels lower in the Charleston area. The average wind speed during the ozone season is 8.39 mph.

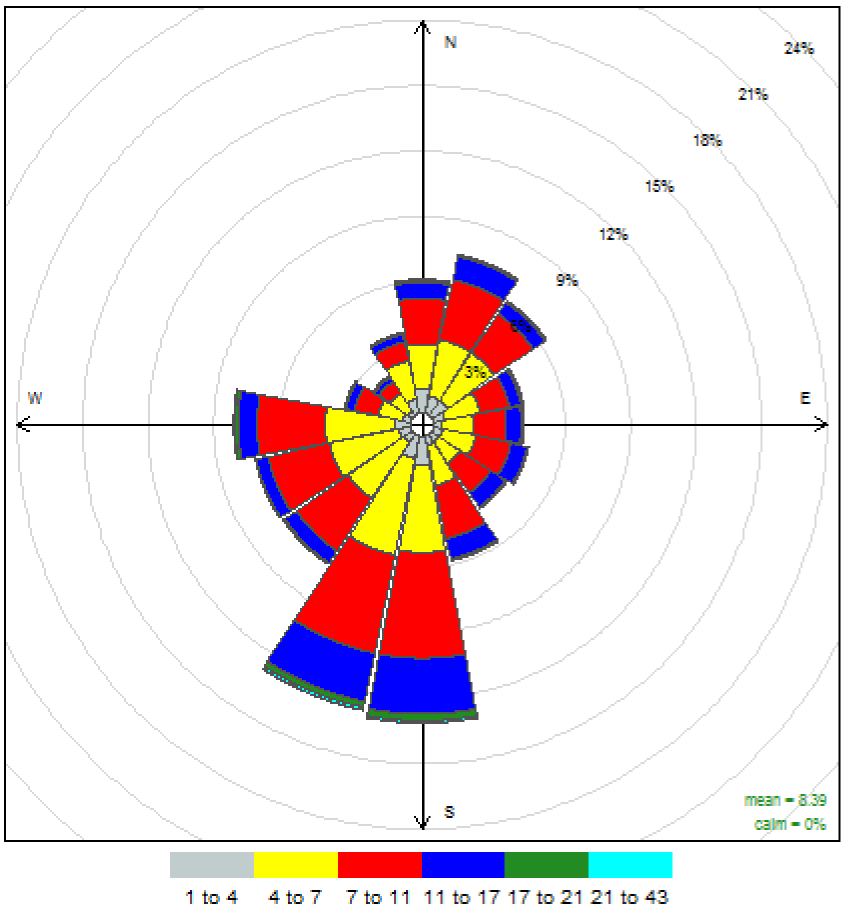
The remaining windroses were created for each seasonal quarter of the year. The first quarter runs from March through May, with the second quarter running from June through August. September through November represents the third quarter, while the fourth quarter includes the months of December through February. The first quarter wind rose shows two dominant wind directions. During the first quarter (spring season), wind directions most frequently come from the south, south-southwest, and westerly directions. The average wind speed during the first quarter is 9.55 mph. The second quarter (summer season) wind rose for the Charleston airport shows most common wind directions come from the south and south-southwest. This southerly wind direction is the result of the sea breeze that develops during the warm months across the coastal areas of South Carolina. The sea breeze develops during the afternoon as the cooler air off of the ocean moves inland into the southern coastal plain. As the sea breeze pushes inland, a southerly flow off the ocean develops, and this generally keeps ozone levels lower in the Charleston area. The average wind speed during the second quarter is 7.85 mph. The third quarter wind rose (autumn season) shows three dominant wind directions. During the autumn months wind directions from the north, north-northeast, and northeast occur most frequently. The average wind speed during the third quarter is 8.15 mph.

The fourth quarter wind rose (winter season) indicates that wind directions from the west, west-northwest, and south-southwest are most common. The average wind speed during the fourth quarter is 8.87 mph.

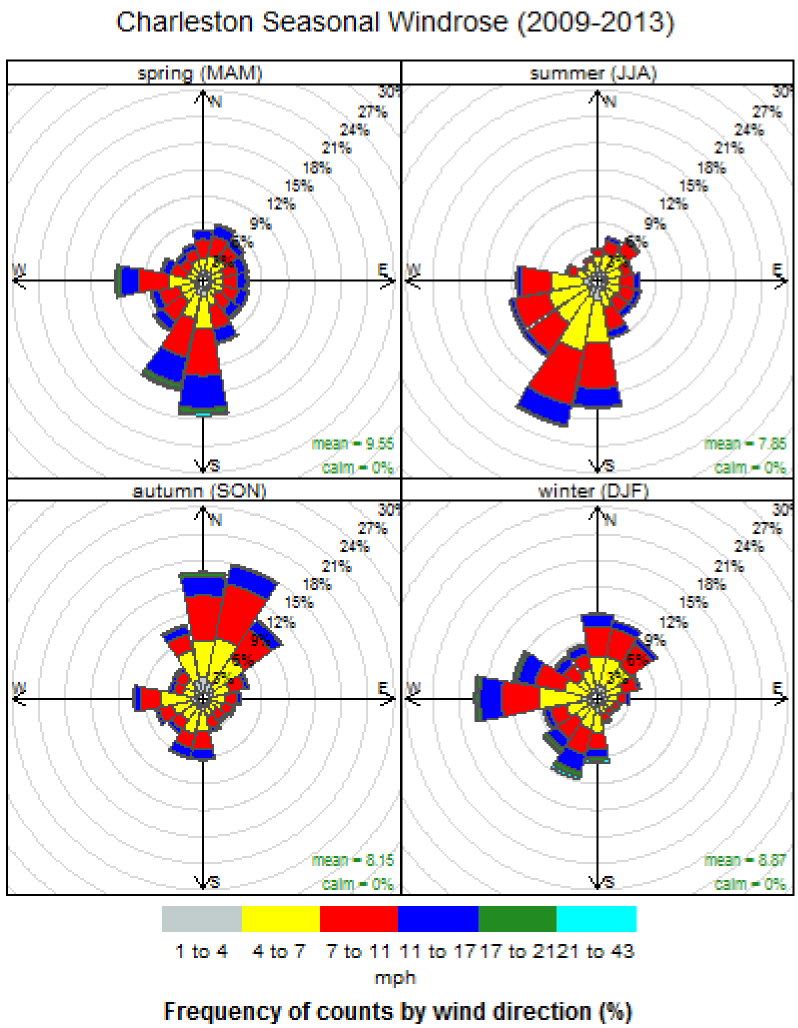
Annual & Seasonal Wind Roses for the Charleston MSA Using the Charleston Airport Wind Data



Charleston Ozone Season Windrose (2009-2013)



Frequency of counts by wind direction (%)


Charleston Seasonal Windrose (2009-2013)
spring (MAM)
summer (JJA)
autumn (SON)
winter (DJF)
N
S
E
W
mean = 9.55
calm = 0%
mean = 7.85
calm = 0%
mean = 8.15
calm = 0%
mean = 8.87
calm = 0%
1 to 4
4 to 7
7 to 11
11 to 17
17 to 21
21 to 43
mph
Frequency of counts by wind direction (%)

Charlotte-Gastonia-Concord MSA Meteorology and Climate

The York area is located in the north-central portion of South Carolina, an area known as the upper Piedmont. The York county area's elevation above sea level is significantly higher than is the Midlands of South Carolina. The York County area meteorological conditions are represented by the Charlotte National Weather Service office station. Charlotte is located just north of York, across south-central North Carolina. Meteorological conditions are a bit more temperate here than the more subtropical conditions across the Midlands and inland, coastal plains. Occasional cold spells can affect the area during the winter months; however, these cold spells are modified by the Appalachian Mountains located north and west of the York area. Chilly, wedge scenarios are common during the cooler months when high pressure, to the north, ridges down just east of the Appalachian Mountains. This pattern results in cloudy, chilly weather with drizzle and sometimes heavier precipitation is possible when weather systems approach from the west or southwest. Summers in the Charlotte area are noticeably milder than the summers across the Midlands of South Carolina. During the summer months, when the Bermuda high is centered close to climatology, very warm weather is common across the upper Piedmont with afternoon thunderstorms possible from time to time. When the Bermuda high is displaced to the south and west of its normal position, hot and dry conditions often develop across the upper Piedmont with little chances for afternoon thunderstorm activity. During these summers, drought can develop across the Piedmont of South Carolina. Ozone exceedances are generally more common during the hot and dry summers.

The Charlotte Douglas International Airport climate data is used in Tables 1, 2, and 3 to represent the Charlotte-Gastonia-Concord MSA. Table 1 shows the average winter and spring maximum and minimum temperatures at the Charlotte-Gastonia-Concord MSA Airport for the climate period beginning in 1981 and ending in 2010. Table 2 shows the average summer and autumn maximum and minimum temperatures along with the average annual temperature at the Charlotte-Douglas International Airport. The average seasonal and annual precipitation totals along with the average annual snowfall amount are found in Table 3.

Charlotte Douglas-International Airport Climate Normals

(Based on 1981-2010 Climate Data from NCDC)

Table 1: The Average Winter (Dec-Feb) and Spring (March-May) Temperatures for the Charlotte Douglas International Airport

Average Winter Maximum Temperature	Average Winter Minimum Temperature	Average Winter Temperature	Average Spring Maximum Temperature	Average Spring Minimum Temperature	Average Spring Temperature
52.8 F	31.4 F	42.1 F	71.3 F	47.3 F	59.3 F

Table 2: The Average Summer (Jun-Aug) and Autumn (Sep-Nov) Temperatures Along With the Average Annual Temperature for the Charlotte Douglas International Airport

Average Summer Maximum Temperature	Average Summer Minimum Temperature	Average Summer Temperature	Average Autumn Maximum Temperature	Average Autumn Minimum Temperature	Average Autumn Temperature
87.5 F	66.6 F	77.1 F	71.8 F	49.5 F	60.6 F
Average Annual Temperature (based on 1981 to 2010 Climate Normals) is 59.9 F degrees.					

Table 3: The Average Seasonal and Annual Precipitation Totals Along With the Average Annual Total Amount of Snowfall for the Charlotte Douglas International Airport

Average Winter Precipitation Totals	Average Spring Precipitation Totals	Average Summer Precipitation Totals	Average Autumn Precipitation Totals	Average Annual Precipitation Totals	Average Annual Snowfall Totals
9.98 in	**10.23 in**	**11.64 in**	**9.78 in**	**41.63 in**	**4.3 in**

Seasonal and Annual Wind Patterns Across the Charlotte-Gastonia-Concord MSA

The National Weather Service station at the Charlotte Douglas International airport was used to create windroses for the north-central portions of South Carolina. The Charlotte station is located in an indention that runs from north to south across the area. This indention in topography skews the wind directions to a more northerly and southerly direction.

An annual windrose was created for the Charlotte area using 2009 through 2013 wind data. On an annual basis, the windrose shows that the dominant wind directions are from the south, north, south-southwest, and southwest. This more northerly and southerly component to the wind direction is related to the topography in the Charlotte area. The average annual wind speed at the Charlotte Douglas International Airport is 7.39 mph.

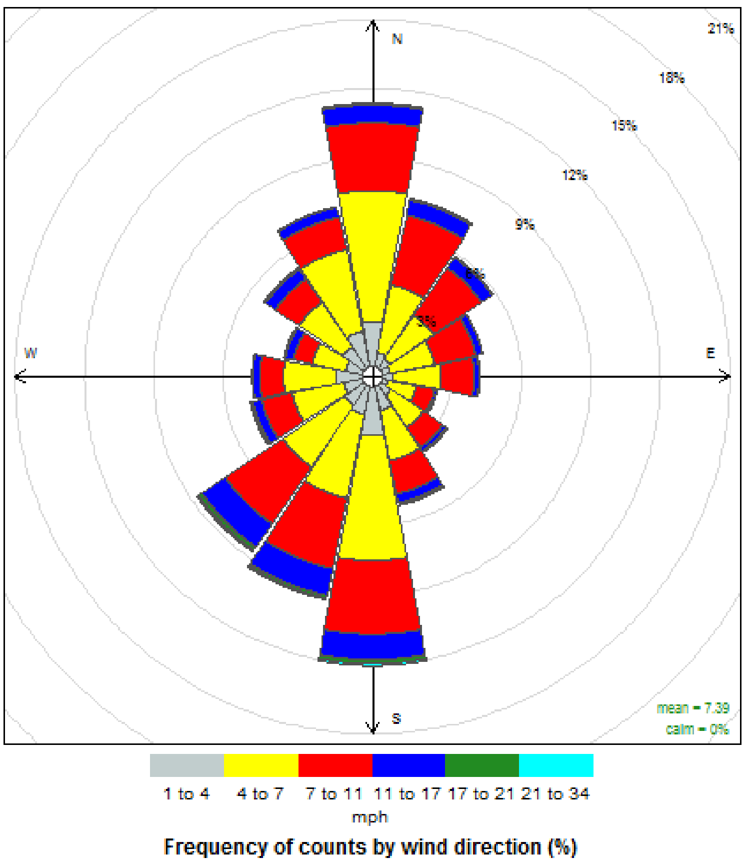
The second windrose was created for the ozone season at the Charlotte Douglas International Airport. Ozone season runs from April through October in the York County area. The Ozone season windrose looks very similar to the annual windrose at Charlotte. During the ozone season, wind directions most frequently come from the south, north, south-southwest, and southwest. The average wind speed during this period is 7.16 mph.

The next four windroses are broken up by seasonal quarters. March through May represents the first quarter, June through August represents the second quarter, September through December represents the third quarter, and the fourth quarter begins in October and runs through December. The most frequent wind directions during the first quarter (spring season) are from the south, south-southwest, north, and southwest. The average wind speed during the first quarter is 8.1 mph. The next wind rose represents the second quarter (summer season). During the second quarter, the most common wind directions are from the south, north, southwest, and south-southwest. The average wind speed during the second quarter is 6.57 mph. The third quarter wind rose (autumn season) indicates that a north and north-northeasterly wind direction occurs most often. The average wind speed during the third quarter is 7.14 mph.

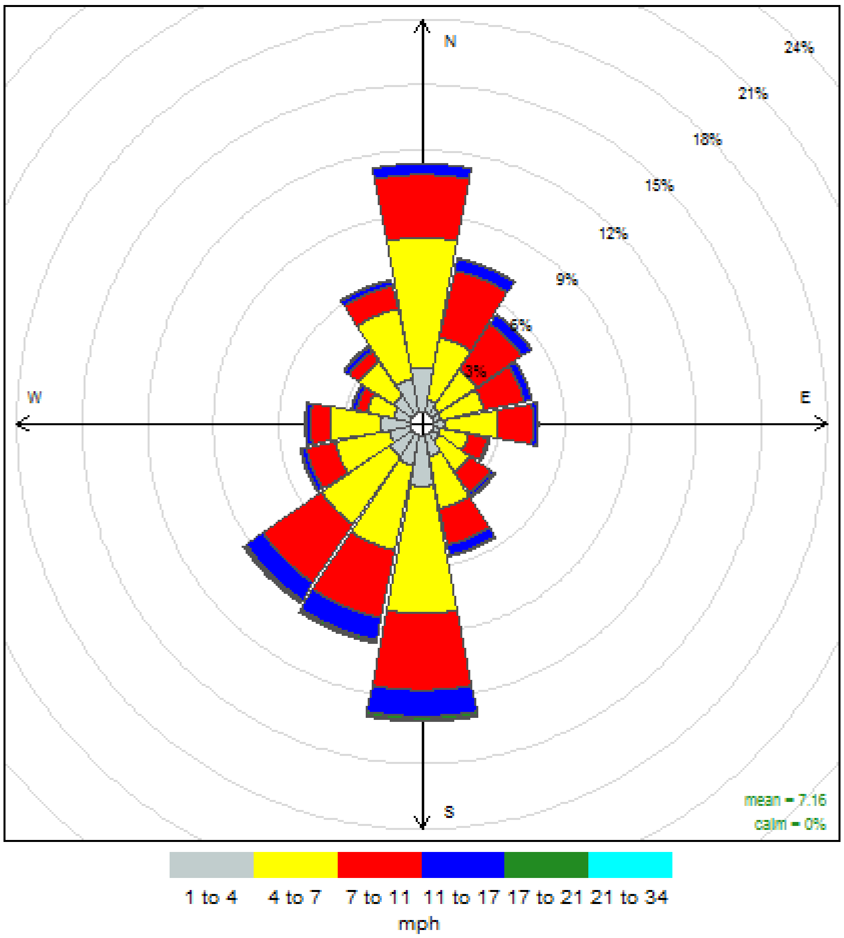
The fourth quarter wind rose (winter season) shows wind directions most commonly from the south, south-southwest, north, northeast, and southwest. The average fourth quarter wind speed at the Charlotte International Airport is 7.64 mph.

Annual & Seasonal Wind Roses for the Charlotte-Gastonia-Concord MSA Using the Charlotte Douglas International Airport Wind Data

Charlotte Annual Windrose (2009-2013)

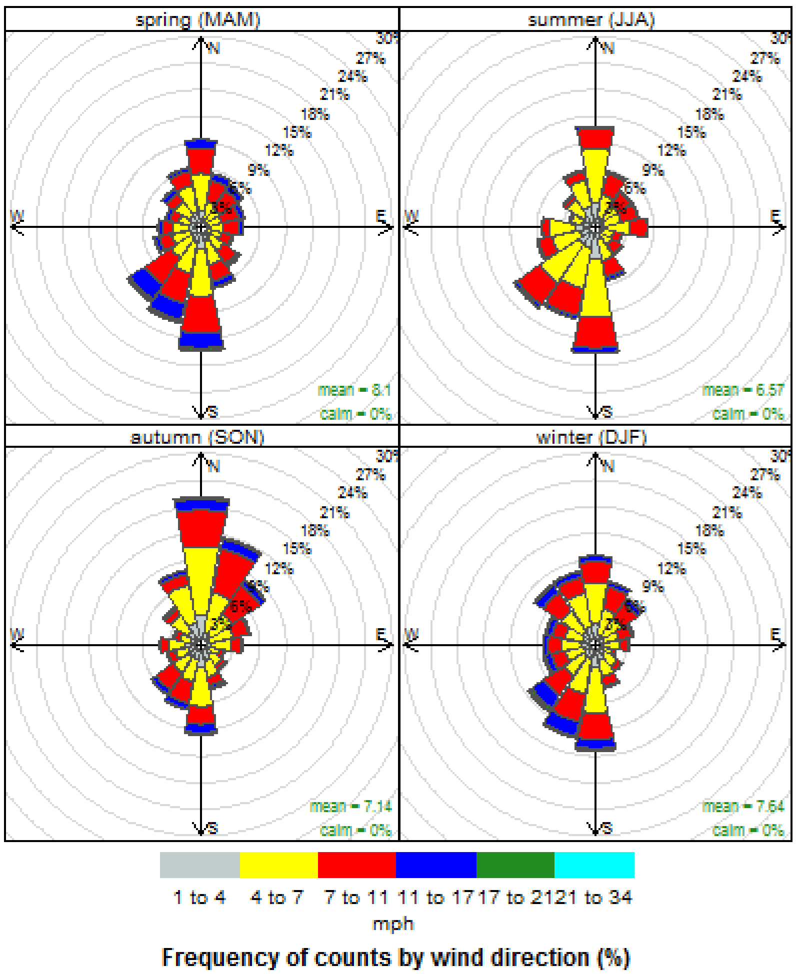


Charlotte Ozone Season Windrose (2009-2013)



Frequency of counts by wind direction (%)

Charlotte Seasonal Windrose (2009-2013)



Gaffney mSA Meteorology and Climate

Gaffney is located in the upper Piedmont of South Carolina, in Cherokee County. This area is frequently referred to as the Upstate of South Carolina. The Cherokee county area's elevation above sea level is significantly higher than is the Midlands of South Carolina. The Cherokee County area is represented by the National Weather Service office station known as Greer. Greer is located almost half way between the city of Greenville and Spartanburg. Meteorological conditions are a bit more temperate here than the more subtropical conditions across the Midlands and inland, coastal plains. Occasional cold spells can affect the area during the winter months; however, these cold spells are modified by the Appalachian Mountains located just north and west of the Gaffney area. Chilly, wedge scenarios are common during the cooler months when high pressure, to the north, ridges down just east of the Appalachian Mountains. This pattern results in cloudy, chilly weather with drizzle and sometimes heavier precipitation is possible when weather systems approach from the west or southwest. Summers in the Gaffney area are noticeably milder than the summers across the Midlands of South Carolina. During the summer months when the Bermuda high is centered close to climatology, very warm weather is common across the Upstate with afternoon thunderstorms possible from time to time. When the Bermuda high is displaced to the south and west of its normal position, hot and dry conditions often develop across the Upstate with little chances for afternoon thunderstorm activity. During these summers, drought can develop across the Upstate of South Carolina. Elevated ozone concentrations are generally more common during these hot and dry summers. .

The Greenville-Spartanburg Airport climate data is used in Tables 1, 2, and 3 to represent the Gaffney MSA. Table 1 shows the average winter and spring maximum and minimum temperatures at the Greenville Spartanburg Airport for the climate period beginning in 1981 and ending in 2010. Table 2 shows the average summer and autumn maximum and minimum temperatures along with the average annual temperature for the Greenville Spartanburg Airport. The average seasonal and annual precipitation totals along with the average annual snowfall amounts are found in Table 3.

** Greenville windroses were used instead of Charlotte windroses. The reason for this is the wind directions in the Charlotte area are skewed from north to south or south to north due to an indention in the topography.

Greenville-Spartanburg Airport Climate Normals

(Based on 1981-2010 Climate Data from NCDC)

Table 1: The Average Winter (Dec-Feb) and Spring (March-May) Temperatures for the Greenville-Spartanburg Airport

Average Winter Maximum Temperature	Average Winter Minimum Temperature	Average Winter Temperature	Average Spring Maximum Temperature	Average Spring Minimum Temperature	Average Spring Temperature
54.3 F	33.6 F	43.9 F	72.5 F	48.9 F	60.7 F

Table 2: The Average Summer (Jun-Aug) and Autumn (Sep-Nov) Temperatures Along With the Average Annual Temperature for the Greenville-Spartanburg Airport

Average Summer Maximum Temperature	Average Summer Minimum Temperature	Average Summer Temperature	Average Autumn Maximum Temperature	Average Autumn Minimum Temperature	Average Autumn Temperature
88.8 F	68.0 F	78.4 F	72.8 F	51.1 F	62.0 F
Average Annual Temperature (based on 1981 to 2010 Climate Normals) is 61.3 F degrees.					

Table 3: The Average Seasonal and Annual Precipitation Totals for the Gaffney 6 E, SC Station Along With the Average Annual Total Amount of Snowfall for the Greenville-Spartanburg Airport

Average Winter Precipitation Totals	Average Spring Precipitation Totals	Average Summer Precipitation Totals	Average Autumn Precipitation Totals	Average Annual Precipitation Totals	Average Annual Snowfall Totals
11.90 in	**11.64 in**	**13.08 in**	**10.57 in**	**47.19 in**	**4.7 in**

Seasonal and Annual Wind Patterns Across the Gaffney MSA

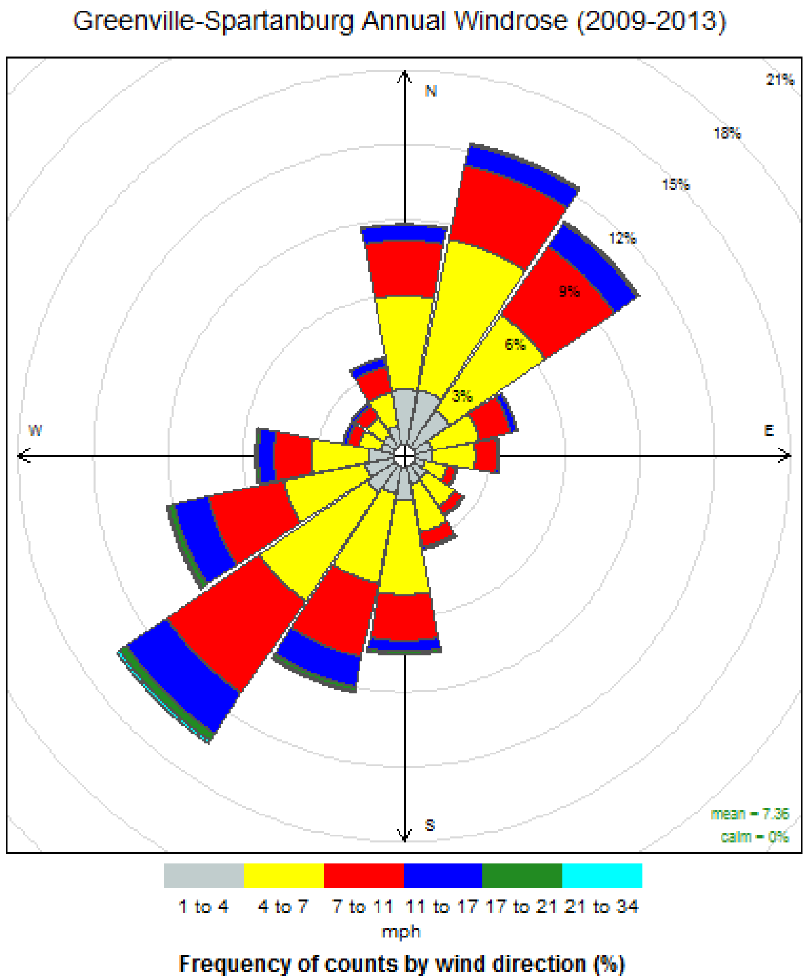
Using the Greenville-Spartanburg National Weather Service Data, a series of windroses was developed for the upper Piedmont of South Carolina. The annual windrose represents wind patterns across the Gaffney MSA throughout the entire year. On an annual basis, the dominant wind directions are from the southwest, west, west-southwest and from the northeast. Wind directions that are least common include south-southeast winds, southeast, east-southeast, easterly, northwesterly, and north-northwesterly winds. The average wind speed for an entire year is 7.36 mph.

The second windrose represents the wind patterns during ozone season. Ozone season runs from April through October across the Gaffney MSA. Wind patterns during the ozone season look very similar to the annual wind rose. Average wind speeds for the ozone season windrose are 7.08 mph.

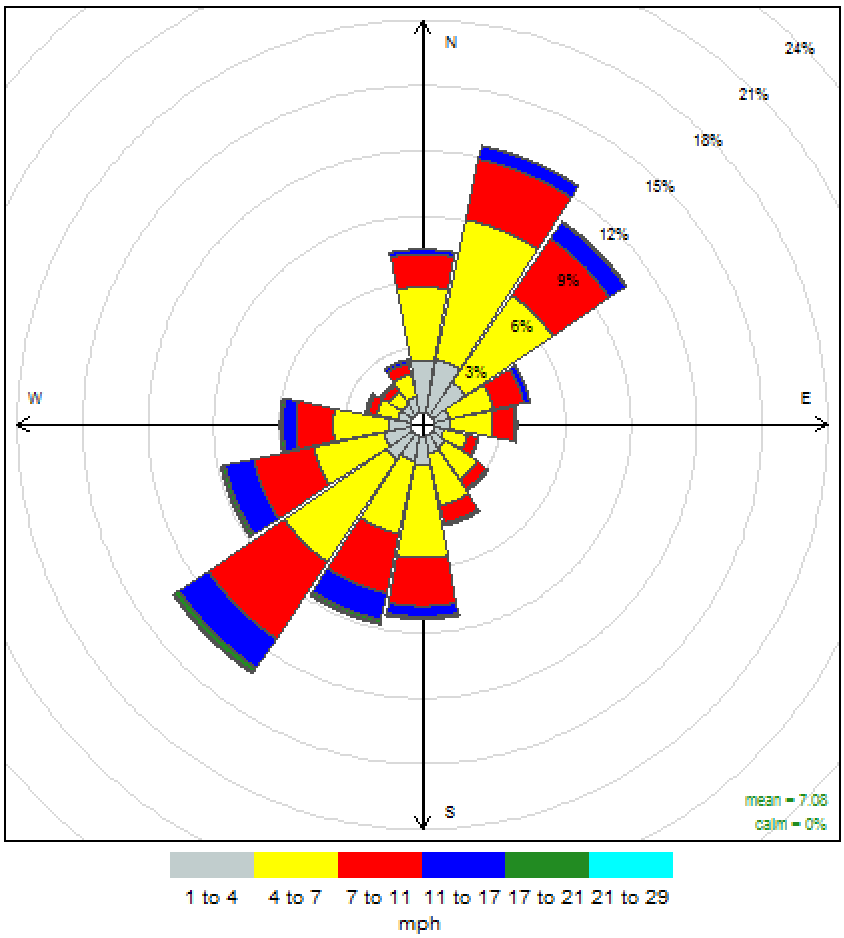
The next four wind roses are broken up into the four quarters that make up one year. March through May represents the first quarter, June through August represents the second quarter, the third quarter includes September through November, and the fourth quarter runs from December through February. The first quarter windroses indicates that a southwesterly and northeasterly wind directions are most common. Average wind speeds during the first quarter are 7.92 mph. The second quarter wind rose (summer season) is similar to the first quarter wind rose; however, there is another secondary dominant wind direction out of the west-southwest. Average wind speeds during the second quarter period is 6.62 mph. The third quarter windrose shows a great departure from the annual, first quarter, and second quarter wind roses. During the autumn months, the wind rose indicates a dominant flow out of the northeast and north-northeast. Average wind speeds during this period are 6.99 mph.

The fourth quarter windrose shows winds from the southwest, west-southwest, north, north-northeasterly, occur more frequently than any other wind directions. Average wind speeds during the fourth quarter are 7.80 mph.

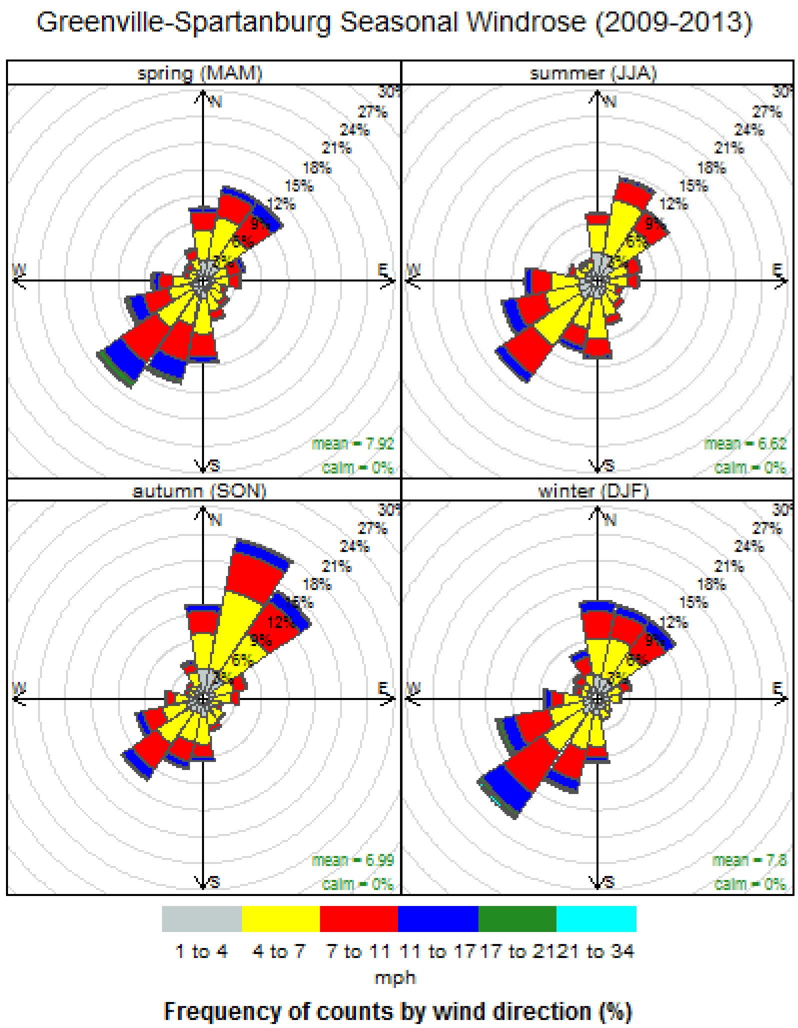
Annual & Seasonal Wind Roses for the Gaffney MSA Using the Greenville-Spartanburg Airport Wind Data



Greenville-Spartanburg Ozone Season Windrose (2009-2013)



Frequency of counts by wind direction (%)


Greenville-Spartanburg Seasonal Windrose (2009-2013)
spring (MAM)
summer (JJA)
autumn (SON)
winter (DJF)
mean = 7.92
calm = 0%
mean = 6.62
calm = 0%
mean = 6.99
calm = 0%
mean = 7.8
calm = 0%
1 to 4
4 to 7
7 to 11
11 to 17
17 to 21
21 to 34
mph
Frequency of counts by wind direction (%)

Chesterfield County Meteorology and Climate

Chesterfield County, South Carolina is located in the northeastern portion of South Carolina, just south of the North Carolina border. The most representative meteorological site for Chesterfield is located in North Carolina, and is known as the Laurinburg-Maxton station. Chesterfield County lies in between the more temperate climate to the north and west and the more subtropical climate to the south and east. Winters are generally mild with sporadic, cold outbreaks which are modified by the Appalachian Mountains. Chilly, wedge scenarios are common during the cooler months when high pressure, to the north, ridges down just east of the Appalachian Mountains. This pattern results in cloudy, chilly weather with drizzle and sometimes heavier precipitation is possible when weather systems approach from the west or southwest. During the summer months, when the Bermuda high is centered close to climatology, very warm to hot weather is common across the Chesterfield County area with afternoon thunderstorms possible from time to time. When the Bermuda high is displaced to the south and west of its normal position, hot and dry conditions often develop across the Chesterfield County with little chances for afternoon thunderstorm activity. During these summers, drought can develop across the South Carolina. Elevated Ozone concentrations are generally more common during these hot and dry summers.

The Chesterfield site's climate data is used in Tables 1, 2, and 3 to represent Chesterfield County. Table 1 shows the average winter and spring maximum and minimum temperatures at the Chesterfield site for the climate period beginning in 1981 and ending in 2010. Table 2 shows the average summer and autumn maximum and minimum temperatures along with the average annual temperature for the Chesterfield site. The average seasonal and annual precipitation totals along with the average annual snowfall amounts are found in Table 3.

Table 1: The Average Winter (Dec-Feb) and Spring (March-May) Temperatures for the Chesterfield Site

Average Winter Maximum Temperature	Average Winter Minimum Temperature	Average Winter Temperature	Average Spring Maximum Temperature	Average Spring Minimum Temperature	Average Spring Temperature
58.0 F	31.9 F	45.0 F	75.3 F	47.2 F	61.2 F

Table 2: The Average Summer (Jun-Aug) and Autumn (Sep-Nov) Temperatures Along With the Average Annual Temperature for the Chesterfield Site

Average Summer Maximum Temperature	Average Summer Minimum Temperature	Average Summer Temperature	Average Autumn Maximum Temperature	Average Autumn Minimum Temperature	Average Autumn Temperature
91.0 F	67.1 F	79.1 F	76.4 F	49.8 F	63.1 F
Average Annual Temperature (based on 1981 to 2010 Climate Normals) is 62.2 F degrees.					

Table 3: The Average Seasonal and Annual Precipitation Totals for Chesterfield, SC Site Along With the Average Annual Total Amount of Snowfall for Cheraw, SC

Average Winter Precipitation Totals	Average Spring Precipitation Totals	Average Summer Precipitation Totals	Average Autumn Precipitation Totals	Average Annual Precipitation Totals	Average Annual Snowfall Totals
10.49 in	10.59 in	15.01 in	10.88 in	46.97 in	0.6 in

Seasonal and Annual Wind Patterns Across for Chesterfield County

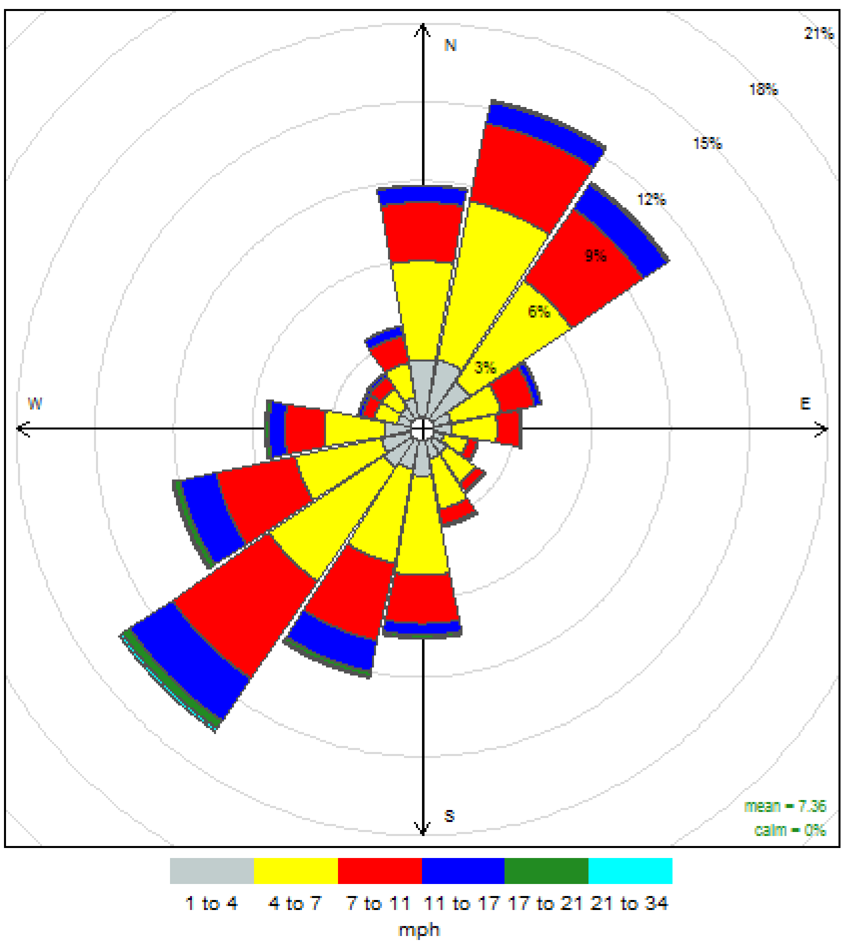
Six windroses were created for the Chesterfield County area using the wind data from the Florence, SC station. The annual and seasonal windroses were created using wind data from 2009 through 2013. The annual wind roses show that wind directions most commonly from the southwest, north-northeast, and northeast. The average annual wind speed at the Florence site is 7.36 mph.

The ozone season in Chesterfield County begins in April and ends on October. The wind rose representing the ozone season shows that the wind direction most frequently comes from the southwest, north-northeast, and northeast. The average wind speed during the ozone season at the Florence site is 7.08 mph.

The next four windroses represents the four seasonal quarters. The first quarter (spring season) begins in March and ends on May, the second quarter (summer season) begins in June and ends on August, the third quarter (autumn season) begins in September and ends in November, while the fourth quarter (winter season) begins in December and ends in February. The first quarter wind rose (spring season) indicates that wind directions frequently come from the southwest, south-southwest, north-northeast, and northeast. The average wind speed during the first quarter is 7.92 mph. The second quarter wind rose (summer season) shows that wind directions most commonly come from the southwest, west-southwest, north-northeast, and northeast. The third quarter average wind speed is 6.62 mph. During the third quarter, the wind rose indicates wind directions frequently out of the north-northeast, northeast, north, and southwesterly. The average wind speed during the third quarter is 6.99 mph. The fourth quarter (winter season) wind rose shows wind directions frequently come from the southwest, west-southwest, north, north-northeast, northeast, and south-southwest. The average wind speed for the fourth quarter is 7.80 mph.

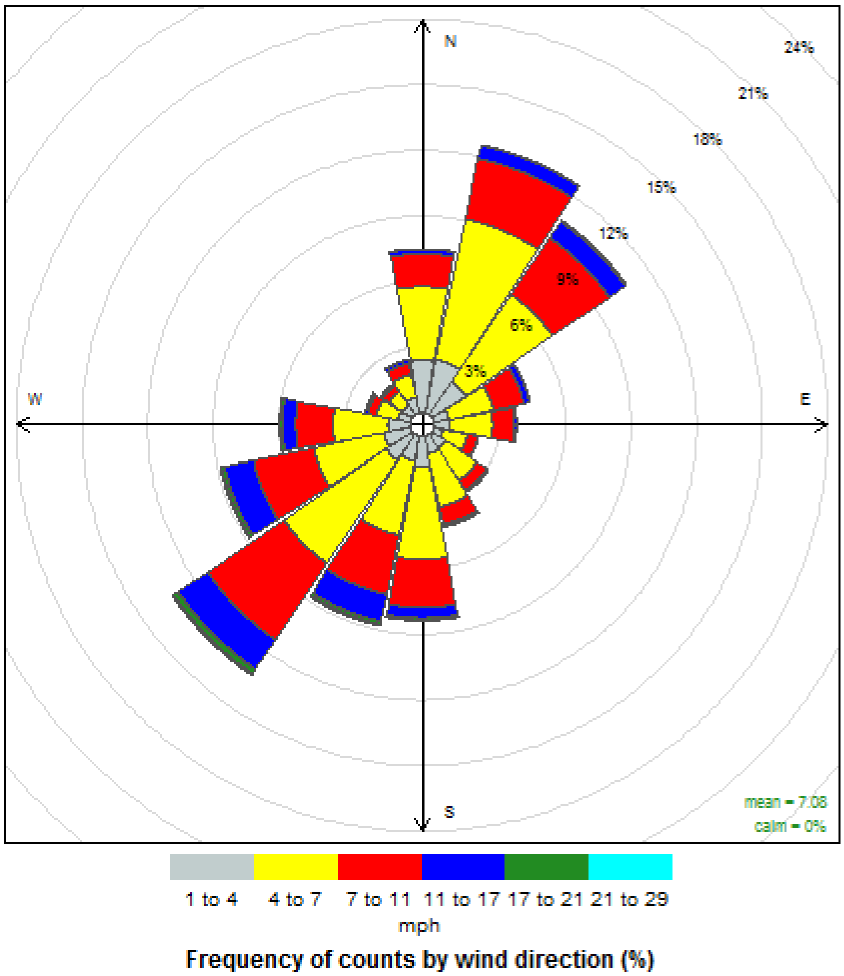
<u>Annual & Seasonal Wind Roses for Chesterfield County Using Florence Wind Data</u>

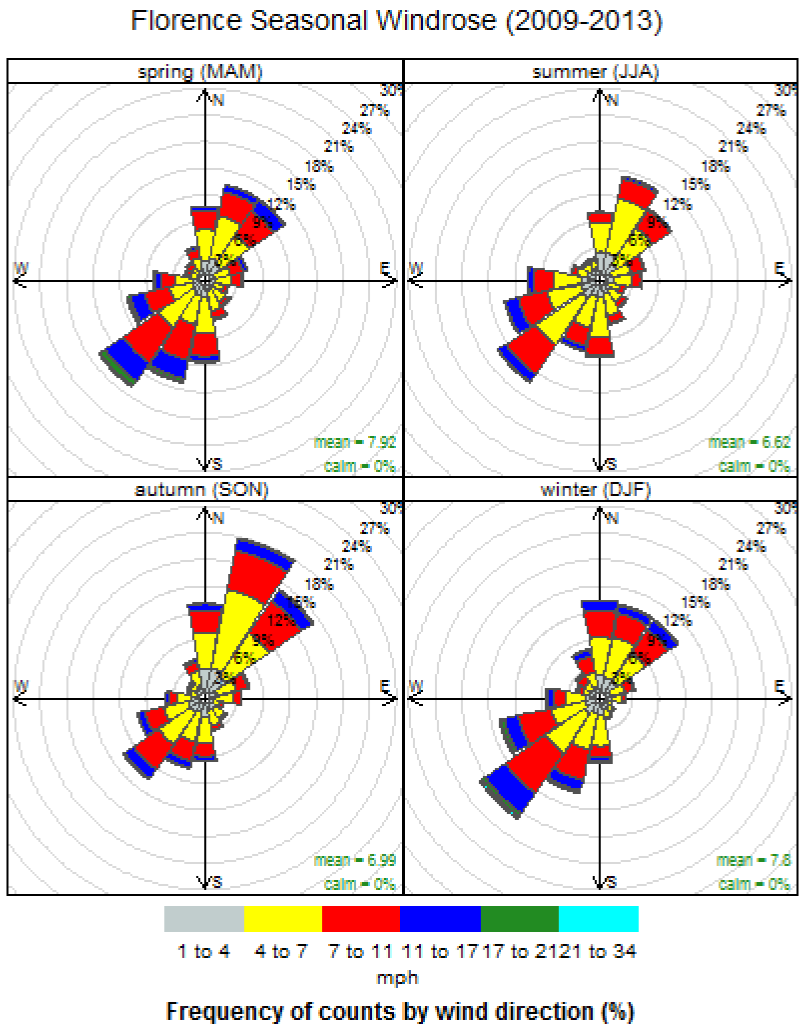
Florence Annual Windrose (2009-2013)



Frequency of counts by wind direction (%)

Florence Ozone Season Windrose (2009-2013)




Florence Seasonal Windrose (2009-2013)
spring (MAM)
summer (JJA)
autumn (SON)
winter (DJF)
N
S
E
W
mean = 7.92
calm = 0%
mean = 6.62
calm = 0%
mean = 6.99
calm = 0%
mean = 7.6
calm = 0%
1 to 4
4 to 7
7 to 11
11 to 17
17 to 21
21 to 34
mph
Frequency of counts by wind direction (%)

Colleton County Meteorology and Climate

Most pollutant concentrations are generally lower in the Colleton County area than in other parts of South Carolina. This is primarily due to the sea breeze which pushes inland during the warmer months. In many instances, this meteorological phenomenon cleans out the air in coastal counties of South Carolina. As a result, the air quality is good across Colleton County much of the time. Colleton County's climate is subtropical with mild winters. During the winter months, cold air masses are modified significantly, having a hard time passing across the Appalachian Mountains. Summers are hot and humid across the lower coastal plains. During a normal summer, the Bermuda high pressure's western flank covers the Southeastern United States. This pumps in a very warm, moist, and unstable air mass across the Southeast, resulting in scattered afternoon and evening thunderstorms across coastal South Carolina. During the warmer months, a pressure gradient develops between the ocean and the land. The colder water temperatures and warmer land temperatures result in lower pressure across the land with higher pressure just above the ocean. This sets up a pressure gradient which causes winds to blow from the ocean to the land. As a result, the sea breeze develops during the warmer months. Winds blow from the oceans (from the south) northward across the land. This ocean to land breeze (the sea breeze) results in cleaner air across the coastal counties of South Carolina. Since the Ashton monitoring site is located inland across the lower coastal plains, the sea breeze generally pushes into the Ashton monitoring area during the late afternoon hours. This is generally during the maximum heating of the day. The arrival of the sea breeze front in addition to maximum heating that occurs late in the day, results in a good coverage of afternoon and evening thunderstorms across inland Colleton County. During some summers, the Bermuda high is centered south and west of its normal position, cutting off Gulf moisture and resulting in very hot and dry summers across the coastal counties. In addition, this pattern also suppresses the sea breeze front. When this occurs, the normal scattered afternoon and evening thunderstorm activity is suppressed, and much of the area may experience drought. Ozone concentrations tend to be higher during these hot and dry summers.

The Walterboro 1 SW climate data is used in Tables 1, 2, and 3 to represent the Colleton MSA. Table 1 shows the average winter and spring maximum and minimum temperatures at the Walterboro 1 SW site Airport for the climate period beginning in 1981 and ending in 2010. Table 2 shows the average summer and autumn maximum and minimum temperatures along with the average annual temperature for the Walterboro 1 SW site. The average seasonal and annual precipitation totals along with the average annual snowfall amounts are found in Table 3.

<u>Walterboro 1 SW Site Climate Normals</u>

(*Based on 1981-2010 Climate Data from NCDC)*

Table 1: The Average Winter (Dec-Feb) and Spring (March-May) Temperatures for the Walterboro 1 SW Site

Average Winter Maximum Temperature	Average Winter Minimum Temperature	Average Winter Temperature	Average Spring Maximum Temperature	Average Spring Minimum Temperature	Average Spring Temperature
60.2 F	35.7 F	47.9 F	76.7 F	50.4 F	63.5 F

Table 2: The Average Summer (Jun-Aug) and Autumn (Sep-Nov) Temperatures Along With the Average Annual Temperature for the Walterboro 1 SW site

Average Summer Maximum Temperature	Average Summer Minimum Temperature	Average Summer Temperature	Average Autumn Maximum Temperature	Average Autumn Minimum Temperature	Average Autumn Temperature
90.2 F	69.3 F	79.7 F	76.8 F	53.4 F	65.1 F
Average Annual Temperature (based on 1981 to 2010 Climate Normals) is 64.1 F degrees					

Table 3: The Average Seasonal and Annual Precipitation Totals for Walterboro 1 SW Site Along With the Average Annual Total Amount of Snowfall for the Colleton MSA Using the Average Annual Total Amount of snowfall from the Charleston Airport National Weather Service Data

Average Winter Precipitation Totals	Average Spring Precipitation Totals	Average Summer Precipitation Totals	Average Autumn Precipitation Totals	Average Annual Precipitation Totals	Average Annual Snowfall Totals
10.44 in	9.64 in	16.94 in	10.23 in	47.25 in	0.5 in

Seasonal and Annual Wind Patterns Across the Colleton MSA

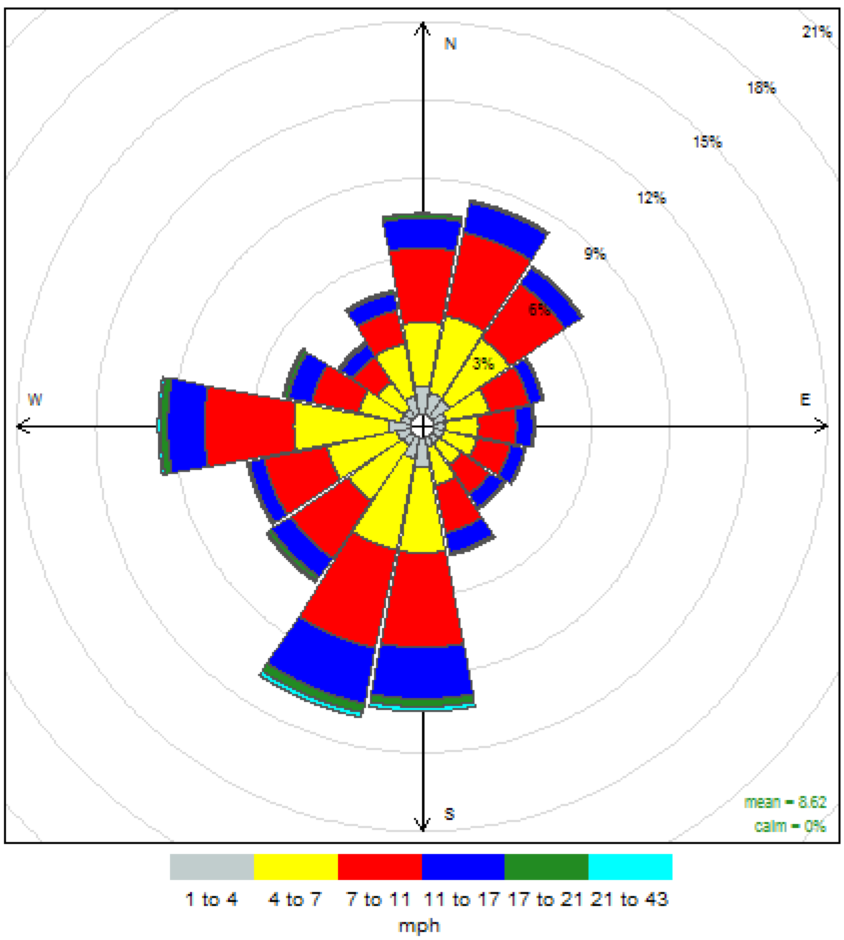
The wind data from the Charleston Airport was used to represent the Colleton County area. It should be noted that the wind patterns across inland Colleton County may not be exactly like the wind patterns in Charleston due to Charleston being closer to the coast. However, the wind patterns should be fairly similar at the Ashton monitoring site and Charleston. The windroses depict the five year wind direction and speeds at the Charleston airport. The annual wind rose indicates that winds most often come from a south, south-southwest, west, north, and north-northeast direction. The average annual wind speed for the Charleston area is 8.62 mph.

A windrose was also created for ozone season which runs from April through October. During the ozone season, the windrose shows that the most dominant wind directions are from the south and south-southwest. This southerly wind direction is the result of the sea breeze that develops during the warm months across the coastal areas of South Carolina. As the sea breeze pushes inland, a southerly flow off the ocean develops, and this generally keeps ozone levels lower in the Charleston area. The average wind speed during the ozone season is 8.39 mph.

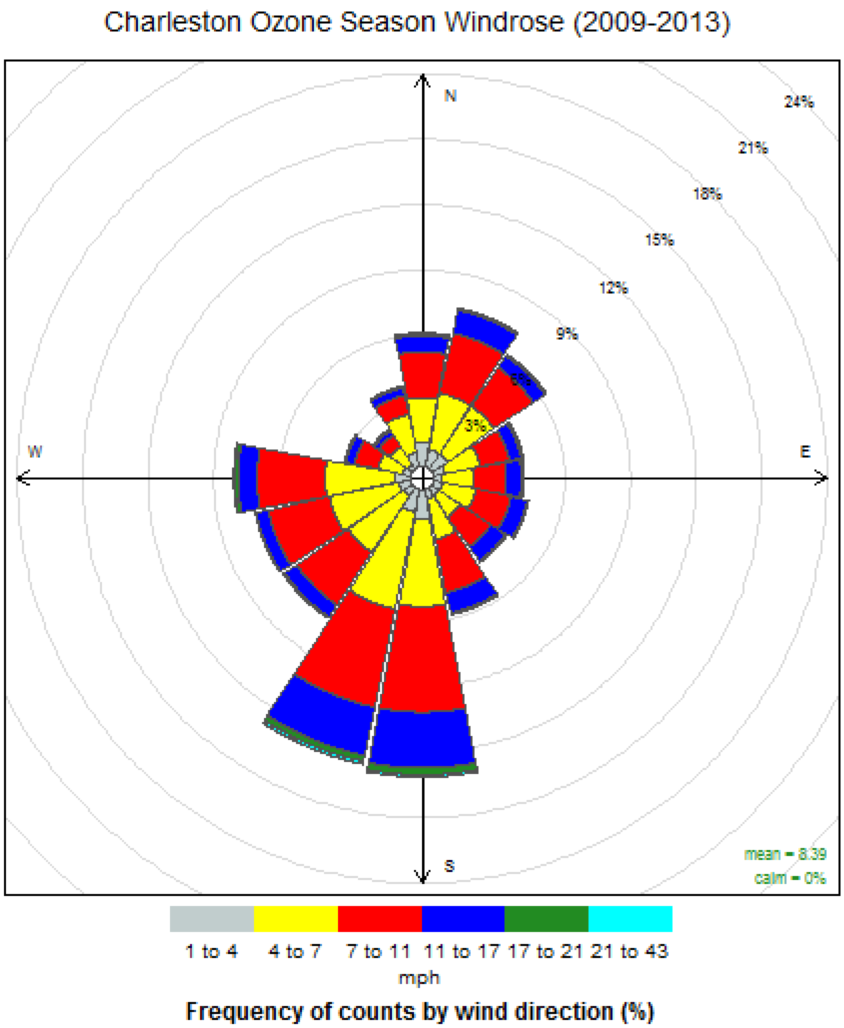
The remaining windroses were created for each seasonal quarter of the year. The first quarter runs from March through May, with the second quarter running from June through August. September through November represents the third quarter, while the fourth quarter includes the months of December through February. The first quarter wind rose shows two dominant wind directions. During the first quarter (spring season), wind directions most frequently come from the south, south-southwest, and westerly directions. The average wind speed during the first quarter is 9.55 mph. The second quarter (summer season) wind rose for the Charleston airport shows most common wind directions come from the south and south-southwest. This southerly wind direction is the result of the sea breeze that develops during the warm months across the coastal areas of South Carolina. The sea breeze develops during the afternoon as the cooler air off of the ocean moves inland into the southern coastal plain. As the sea breeze pushes inland, a southerly flow off the ocean develops, and this generally keeps ozone levels lower in the Charleston area. The average wind speed during the second quarter is 7.85 mph. The third quarter wind rose (autumn season) shows three dominant wind directions. During the autumn months wind directions from the north, north-northeast, and northeast occur most frequently. The average wind speed during the third quarter is 8.15 mph. The fourth quarter wind rose (winter season) indicates that wind directions from the west, west-northwest, and south-southwest are most common. The average wind speed during the fourth quarter is 8.87 mph.

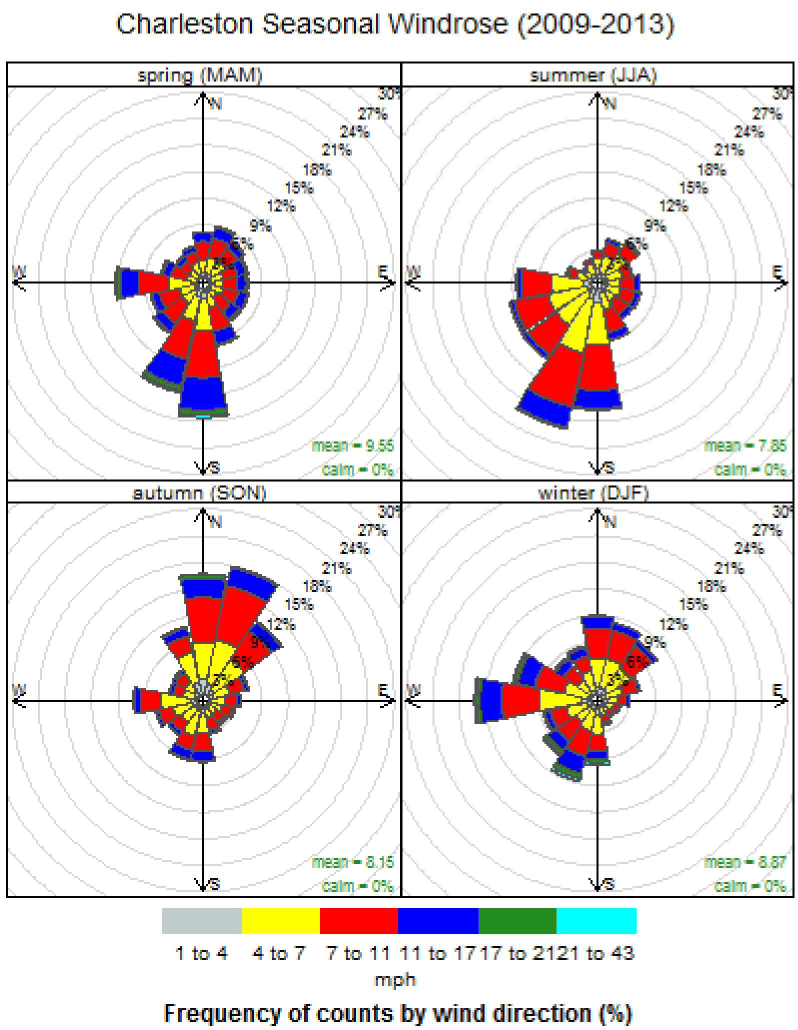
Annual & Seasonal Wind Roses for the Colleton MSA Using the Charleston National Weather Service Airport Wind Data

Charleston Annual Windrose (2009-2013)



Frequency of counts by wind direction (%)


Charleston Ozone Season Windrose (2009-2013)
N
W
E
S
3%
6%
9%
12%
15%
18%
21%
24%
mean = 8.39
calm = 0%
1 to 4
4 to 7
7 to 11
11 to 17
17 to 21
21 to 43
mph
Frequency of counts by wind direction (%)


Charleston Seasonal Windrose (2009-2013)
spring (MAM)
summer (JJA)
autumn (SON)
winter (DJF)
N
E
S
W
mean = 9.55
calm = 0%
mean = 7.85
calm = 0%
mean = 8.15
calm = 0%
mean = 8.87
calm = 0%
1 to 4
4 to 7
7 to 11
11 to 17
17 to 21
21 to 43
mph
Frequency of counts by wind direction (%)

Columbia MSA Meteorology and Climate

The Columbia MSA is located in the central portion of South Carolina which is commonly referred to as the Midlands. The weather service office station that represents the Columbia area is located at the Columbia metropolitan airport in the town of Cayce, which is just southwest of the city of Columbia. The Midlands of South Carolina have sporadic cold outbreaks during the winter months; however, the Appalachian Mountains to the west and north block the coldest of air masses from invading the central portions of the state. For this reason, the Midlands of South Carolina stays relatively mild during most of the winter months when compared to other sections of the Southeast. The terrain and the location away from the ocean results in little relief from the summer heat that is common during the summer months. Hot weather along with scattered afternoon and evening thunderstorms are the norm across the Midlands for three to four months out of the year. Rainfall can be quite variable during the summer months, and this variability is associated with the strength and position of the Bermuda high. During a normal summer, the Bermuda high is centered well out into the Atlantic with its western flank extending into the Southeastern United States. This normal position of the Bermuda high keeps a moist and unstable, southwesterly flow across South Carolina during the summer. With day time heating, scattered afternoon and evening, thunderstorms occur. In some years, the Bermuda high is centered south and west of its normal position, which cuts off the Gulf of Mexico and results in subsidence across the Southeast. This pattern results in fair weather with very hot temperatures. The normal scattered afternoon and evening thunderstorm activity is suppressed, and this pattern is very favorable for droughts across much of the Southeast, including South Carolina. During these very hot and dry summers, ozone levels can rise to above normal levels, resulting in some exceedances across the region.

The Columbia metropolitan airport climate data is used in Tables 1, 2, and 3 to represent the Columbia MSA. Table 1 shows the average winter and spring maximum and minimum temperatures in the Columbia MSA for the climate period beginning in 1981 and ending in 2010. Table 2 shows the average summer and autumn maximum and minimum temperatures along with the average annual temperature for the Columbia MSA. The average seasonal and annual precipitation totals along with the average annual snowfall amounts are found in Table 3.

Columbia Metropolitan Airport Climate Normals

(*Based on 1981-2010 Climate Data from NCDC)*

Table 1: The Average Winter (Dec-Feb) and Spring (March-May) Temperatures for the Columbia Metropolitan Airport

Average Winter Maximum Temperature	Average Winter Minimum Temperature	Average Winter Temperature	Average Spring Maximum Temperature	Average Spring Minimum Temperature	Average Spring Temperature
58.1 F	35.2 F	46.6 F	76.1 F	51.0 F	63.5 F

Table 2: The Average Summer (Jun-Aug) and Autumn (Sep-Nov) Temperatures Along With the Average Annual Temperature for the Columbia Metropolitan Airport

Average Summer Maximum Temperature	Average Summer Minimum Temperature	Average Summer Temperature	Average Autumn Maximum Temperature	Average Autumn Minimum Temperature	Average Autumn Temperature
91.1 F	70.3 F	80.7 F	76.2 F	52.8 F	64.5 F
Average Annual Temperature (based on 1981 to 2010 Climate Normals) is 63.9 F					

Table 3: The Average Seasonal and Annual Precipitation Totals for the Columbia, SC Site Along With the Average Annual Total Amount of Snowfall for the Columbia Metropolitan Airport

Average Winter Precipitation Totals	Average Spring Precipitation Totals	Average Summer Precipitation Totals	Average Autumn Precipitation Totals	Average Annual Precipitation Totals	Average Annual Snowfall Totals
10.41 in	9.32 in	15.41 in	9.45 in	44.59 in	1.5 in

Columbia City (USC) Climate Normals

(Based on 1981-2010 Climate Data from NCDC)

Table 1: The Average Winter (Dec-Feb) and Spring (March-May) Temperatures for the Columbia City (USC) Site

Average Winter Maximum Temperature	Average Winter Minimum Temperature	Average Winter Temperature	Average Spring Maximum Temperature	Average Spring Minimum Temperature	Average Spring Temperature
60.4 F	39.1 F	49.8 F	79.1 F	54.5 F	66.8 F

Table 2: The Average Summer (Jun-Aug) and Autumn (Sep-Nov) Temperatures Along With the Average Annual Temperature for the Columbia City (USC) Site

Average Summer Maximum Temperature	Average Summer Minimum Temperature	Average Summer Temperature	Average Autumn Maximum Temperature	Average Autumn Minimum Temperature	Average Autumn Temperature
93.5 F	71.9 F	82.7 F	78.6 F	56.1 F	67.4 F
Average Annual Temperature (based on 1981 to 2010 Climate Normals) is 66.7 F degrees.					

Table 3: The Average Seasonal and Annual Precipitation Totals for the Columbia City (USC) Site Along With the Average Annual Total Amount of Snowfall for the Columbia Metropolitan Airport

Average Winter Precipitation Totals	Average Spring Precipitation Totals	Average Summer Precipitation Totals	Average Autumn Precipitation Totals	Average Annual Precipitation Totals	Average Annual Snowfall Totals
11.02 in	9.87 in	15.59 in	9.82 in	46.30 in	N/A

Seasonal and Annual Wind Patterns Across the Columbia MSA

Windroses were created for the Columbia area (Midlands), using the meteorological wind data from the Columbia metropolitan airport. The first windrose covers the annual period from 2009 through 2013. During an entire year, the wind pattern across the midlands shows a dominant wind direction from the west, west-southwest, and from the southwest. The average wind speed for the year is 7.45 mph.

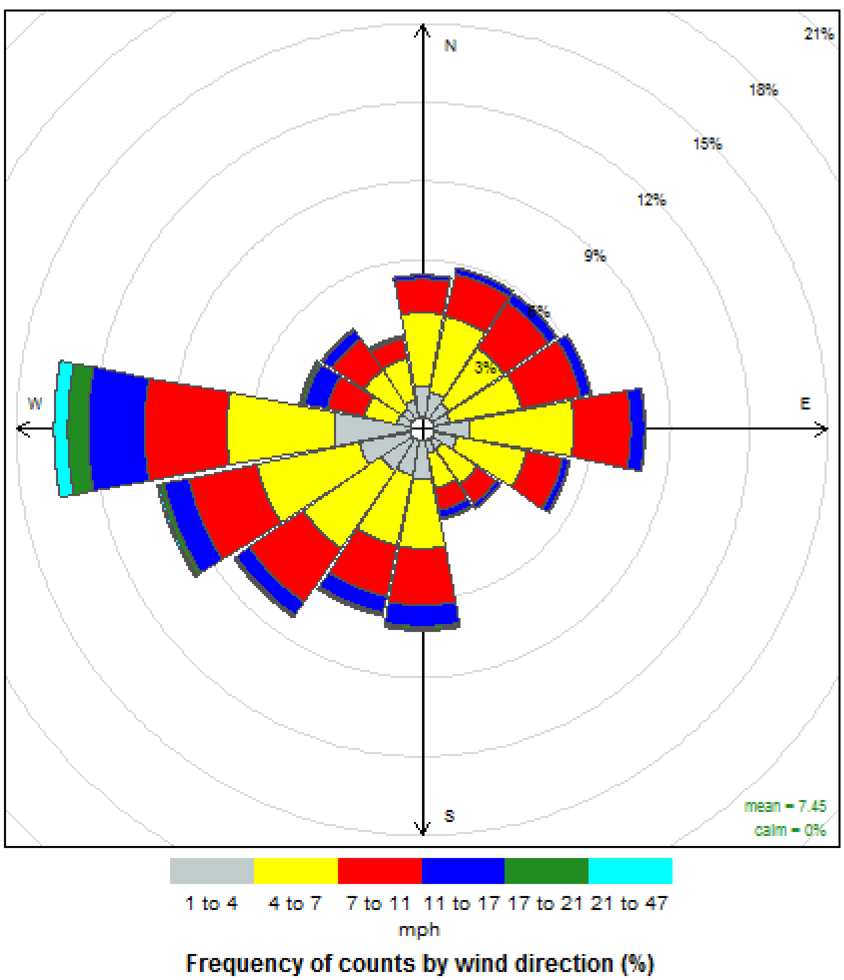
The second windrose represents the ozone season only, which runs from April through October. The ozone season windrose for the Columbia area shows the dominant wind directions areas are from the west, west-southwest, southwest, south and from the east. Ozone precursors are frequently transported into the Midlands from the Charlotte and Atlanta areas, as noted by the ozone season windrose. The average wind speed during ozone season is 7.11 mph.

The next four wind roses are broken up by quarters. There are four quarters for each year. The first quarter runs from March through May, the second quarter runs from June through August, the third quarter runs from September through November, and the fourth quarter runs from December through February.

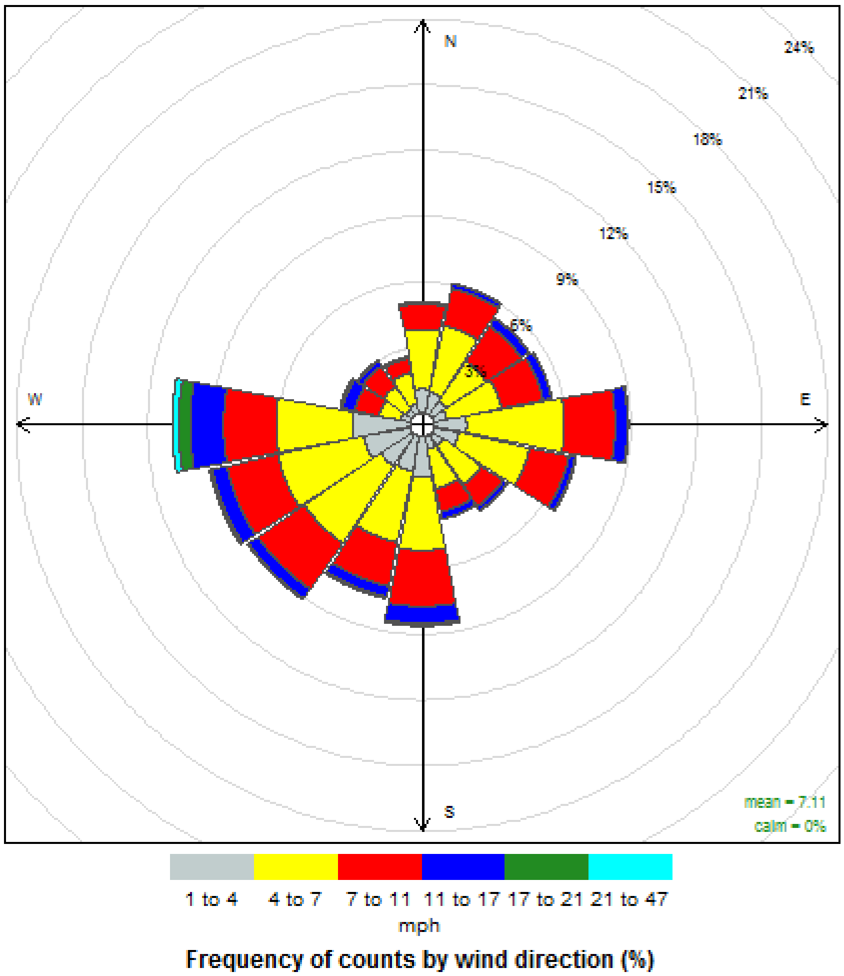
During the first quarter (spring season), the windrose indicates that winds most frequently come from the west, west-southwest, southwest, east, and south. The average wind speed during the first quarter at the Columbia metropolitan airport is 8.16 mph. The second quarter wind rose (summer season) shows that winds most frequently come from the west, west-southwest, west, and from the east. The average wind speed during the second quarter is 6.63 mph. The third quarter wind rose (autumn season) shows a different type of wind pattern across the midlands on SC. During this period, winds most frequently come from the west, north-northeast, north, northeast, and east-northeast. The average wind speed during the third quarter is 6.94 mph. The fourth quarter wind rose (winter season), the winds most frequently come from the west and west-southwest across the midlands. The average wind speed during the fourth quarter is 7.98 mph.

Annual & Seasonal Wind Roses for the Columbia MSA Using the Columbia National Weather Service Airport Wind Data

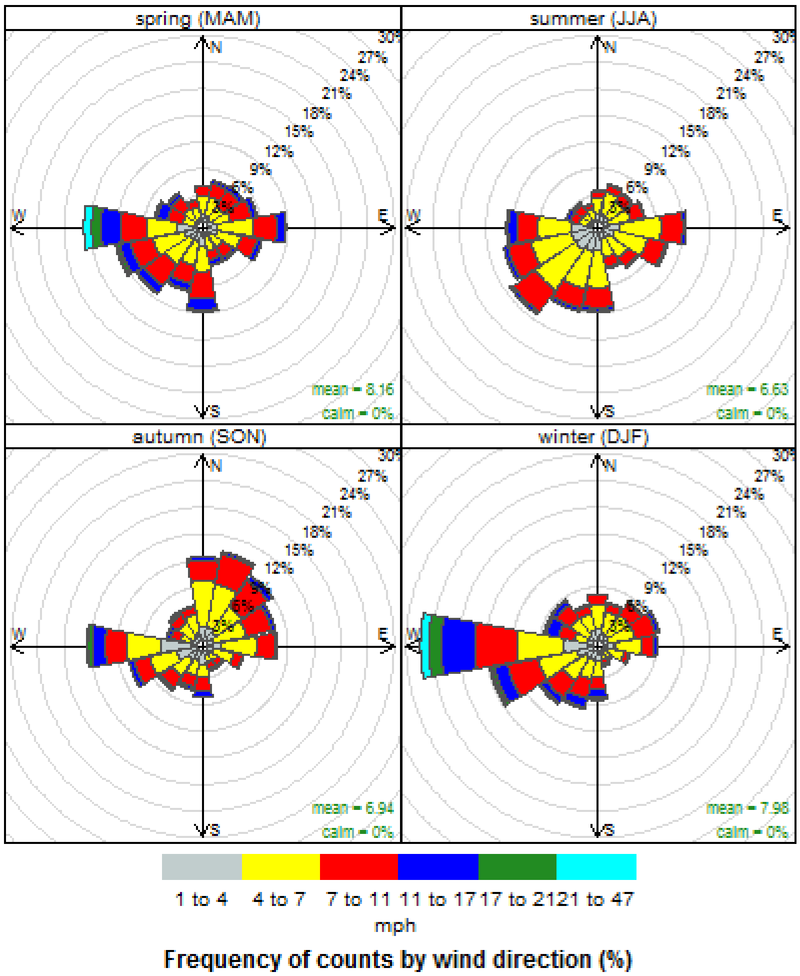
Columbia Annual Windrose (2009-2013)



Columbia Ozone Season Windrose (2009-2013)



Columbia Seasonal Windrose (2009-2013)



Florence MSA Meteorology and Climate

The Florence MSA is located in the inland, northeastern portion of South Carolina which is commonly referred to as the Pee Dee. The weather service office station that represents the Pee Dee area is located in the city of Florence. The Pee Dee of South Carolina has sporadic cold outbreaks during the winter months; however, the Appalachian Mountains to the west and north block the coldest of air masses from invading the Pee Dee area of the state. For this reason, the Pee Dee area of South Carolina stays relatively mild during most of the winter months when compared to other sections of the Southeast. The terrain is almost flat, and the area is located in the northeastern coastal plain of South Carolina. Hot weather along with scattered afternoon and evening thunderstorms are the norm across the Pee Dee for three to four months out of the year. The Pee Dee area is just far enough inland so that it is usually not affected by the sea breeze front. Rainfall can be quite variable during the summer months, and this variability is associated with the strength and position of the Bermuda high. During a normal summer, the Bermuda high is centered well out into the Atlantic with its western flank extending into the Southeastern United States. This normal position of the Bermuda high keeps a moist and unstable, southwesterly flow across South Carolina during the summer. With day time heating, scattered afternoon and evening thunderstorms occur. In some years, the Bermuda high is centered south and west of its normal position, which cuts off the Gulf of Mexico and results in subsidence across the Southeast. This pattern results in fair weather with very hot temperatures. The normal scattered afternoon and evening thunderstorm activity is suppressed, and this pattern is very favorable for droughts across much of the Southeast, including South Carolina. During these very hot and dry summers, ozone levels can rise to above normal levels, resulting in some exceedances across the region.

The Florence regional airport climate data is used in Tables 1, 2, and 3 to represent the Florence MSA. Table 1 shows the average winter and spring maximum and minimum temperatures across the Florence MSA for the climate period beginning in 1981 and ending in 2010. Table 2 shows the average summer and autumn maximum and minimum temperatures along with the average annual temperature for the Florence MSA. The average seasonal and annual precipitation totals along with the average annual snowfall amounts at the Florence Regional Airport are found in Table 3.

Florence Regional Airport Climate Normals

(*Based on 1981-2010 Climate Data from NCDC)*

Table 1: The Average Winter (Dec-Feb) and Spring (March-May) Temperatures for the Florence Regional Airport

Average Winter Maximum Temperature	Average Winter Minimum Temperature	Average Winter Temperature	Average Spring Maximum Temperature	Average Spring Minimum Temperature	Average Spring Temperature
57.5 F	36.2 F	46.8 F	75.4 F	51.2 F	63.3 F

Table 2: The Average Summer (Jun-Aug) and Autumn (Sep-Nov) Temperatures Along With the Average Annual Temperature for the Florence Regional Airport

Average Summer Maximum Temperature	Average Summer Minimum Temperature	Average Summer Temperature	Average Autumn Maximum Temperature	Average Autumn Minimum Temperature	Average Autumn Temperature
89.6 F	70.0 F	79.8 F	75.6 F	53.7 F	64.6 F
Average Annual Temperature (based on 1981 to 2010 Climate Normals)					

Table 3: The Average Seasonal and Annual Precipitation Totals Along With the Average Annual Total Amount of Snowfall for the Florence Regional Airport

Average Winter Precipitation Totals	Average Spring Precipitation Totals	Average Summer Precipitation Totals	Average Autumn Precipitation Totals	Average Annual Precipitation Totals	Average Annual Snowfall Totals
9.16 in	9.21 in	15.12 in	9.42 in	42.91 in	1.5 in

Seasonal and Annual Wind Patterns Across the Florence MSA

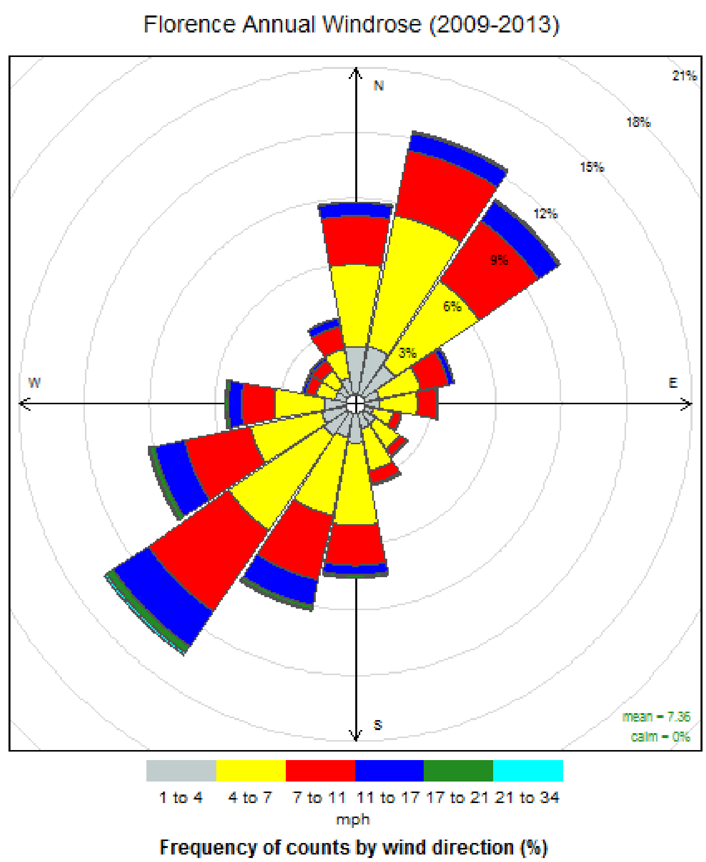
Six windroses were created for the Pee Dee area using the wind data from the Florence site. The annual windrose cover the entire years from 2002 through 2006. During the annual time period, there is no real dominant wind direction; rather the wind comes from a variety of directions. It is easier to identify where the wind directions occur less frequently during an entire year. The least common wind directions during the annual period are from the northwest, north-northwest, west-northwest, south-southeast, southeast, and from the east-southeast. The average wind speed during the annual period is 6.04 knots with calm winds occurring seventeen percent of the time.

The wind pattern during the ozone season, which runs from April through October, is very similar to the annual wind pattern. Once again, the least common wind directions are from the northwest, north-northwest, west-northwest, south-southeast, southeast, and from the east-southeast. The average wind speed during the ozone season is 5.84 knots with calm winds occurring seventeen percent of the time.

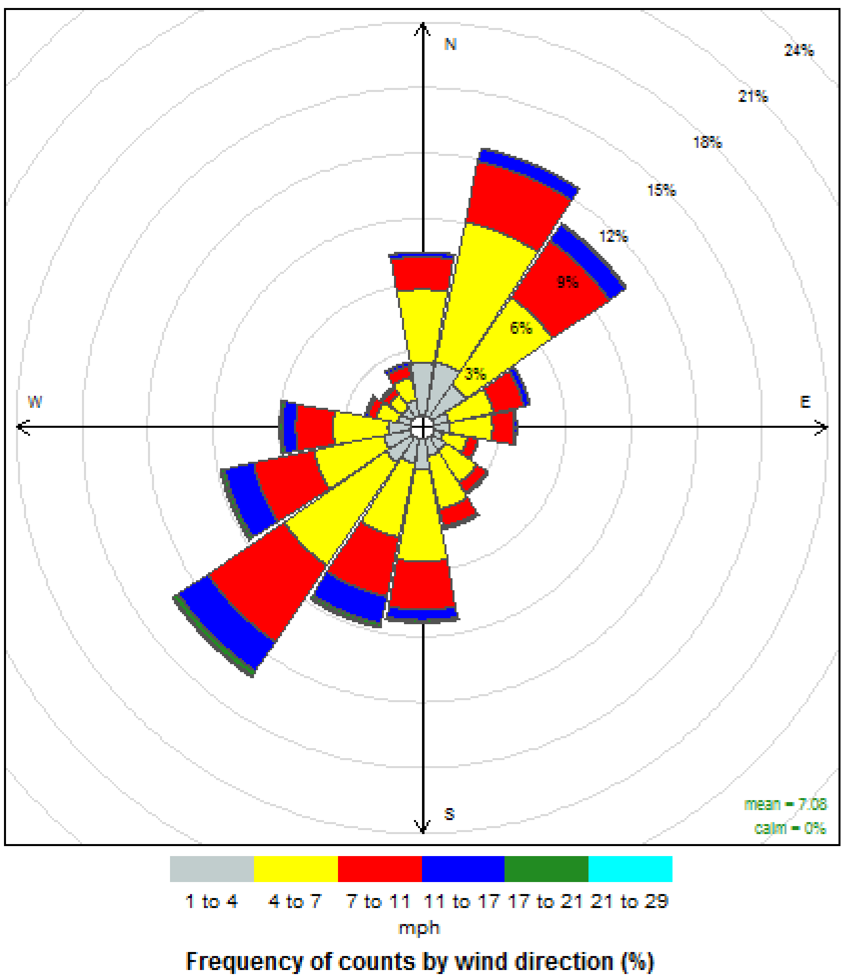
Quarterly windroses make up the next four windroses for the Pee Dee area. The first quarter runs from January through March, the second quarter runs from April through June, the third quarter runs from July through September, and the fourth quarter begins in October and ends in

December. During the first quarter, the windrose shows a variety of wind directions with the more dominant directions being from the north, northeast, west, and southwest. The average wind speed during the first quarter is 6.84 knots with calm winds occurring thirteen percent of the time. The second quarter windrose shows a different wind pattern than the previous windroses for the Florence area. Westerly, west-southwest, southwest, and south-southwesterly wind direction occur more often than the other wind directions during the second quarter. The average wind speed for the second quarter is 6.42 knots with calm winds occurring thirteen percent of the time. During the third quarter, the windrose shows a variety of different wind directions are common. Northwesterly, north-northwesterly, west-northwesterly, easterly, east-southeasterly, southeasterly, south-southeasterly, and southerly wind directions are the least common during the third quarter. The average wind speed during the third quarter is 5.49 knots with calm winds occurring nineteen percent of the time. The fourth quarter wind rose looks different than any of the other windroses for the Florence area. By far the most dominant wind directions for the fourth quarter are from the north, north-northeast, and northeast. A northerly and northeasterly wind direction becomes more common across much of South Carolina during the cooler months. Average wind speeds during the fourth quarter are 5.49 knots with calm winds occurring 22 percent of the time.

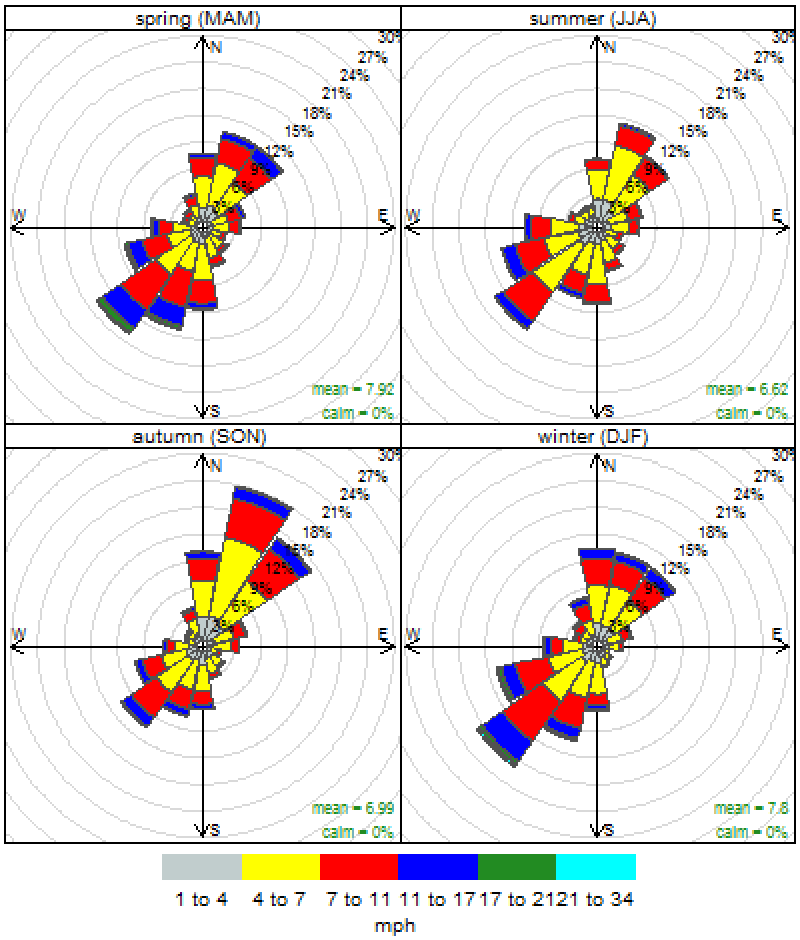
Annual & Seasonal Wind Roses for the Florence MSA Using the Florence Airport Wind Data



Florence Ozone Season Windrose (2009-2013)



Florence Seasonal Windrose (2009-2013)



Frequency of counts by wind direction (%)

Georgetown County Airport Climate Normals

(*Based on 1981-2010 Climate Data from NCDC)*

Georgetown mSA Meteorology and Climate

Most pollutant concentrations are generally lower in the Georgetown County area than in other parts of South Carolina. This is primarily due to the sea breeze which pushes inland during the warmer months. In many instances, this meteorological phenomenon cleans out the air in coastal counties of South Carolina. As a result, the air quality is good across Georgetown County much of the time. Georgetown's climate is marine, subtropical with mild winters and very warm and humid summers. During the winter months, cold air masses are modified significantly, having a difficult time passing across the Appalachian Mountains. In addition, the close proximity of the Gulf Stream helps to modify cold air masses. During a normal summer, the Bermuda high pressure's western flank covers the Southeastern United States. This pumps in a very warm, moist, and unstable air mass across the Southeast, resulting in scattered afternoon and evening thunderstorms across coastal South Carolina. During the warmer months, a pressure gradient develops between the ocean and the land. The colder water temperatures and warmer land temperatures result in lower pressure across the land with higher pressure just above the ocean. This sets up a pressure gradient which causes winds to blow from the ocean to the land. As a result, the sea breeze develops during the warmer months. As a result, winds blow from the oceans (from the south) northward across the land. This ocean to land breeze (the sea breeze) results in cleaner air across the coastal counties of South Carolina. During some summers, the Bermuda high is centered south and west of its normal position, cutting off Gulf moisture and resulting in hot and dry summers across the coastal counties. When this occurs, the normal scattered afternoon and evening thunderstorm activity is suppressed, and much of the area may experience drought. Ozone concentrations tend to be higher during these hot and dry summers.

The Georgetown County airport climate data is used in Tables 1, 2, and 3 to represent the Georgetown MSA. Table 1 shows the average winter and spring maximum and minimum temperatures at the Georgetown County Airport site for the period beginning in 1981 and ending in 2010. Table 2 shows the average summer and autumn maximum and minimum temperatures along with the average annual temperature across the Georgetown MSA. The average seasonal and annual precipitation totals are found in Table 3.

<u>**Georgetown County Airport Climate Normals**</u>

(Based on 1981-2010 Climate Data from NCDC)

Table 1: The Average Winter (Dec-Feb) and Spring (March-May) Temperatures for the Georgetown County Airport

Average Winter Maximum Temperature	Average Winter Minimum Temperature	Average Winter Temperature	Average Spring Maximum Temperature	Average Spring Minimum Temperature	Average Spring Temperature
59.5 F	36.8 F	48.2 F	75.4 F	51.5 F	63.4 F

Table 2: The Average Summer (Jun-Aug) and Autumn (Sep-Nov) Temperatures Along With the Average Annual Temperature for the Georgetown County Airport

Average Summer Maximum Temperature	Average Summer Minimum Temperature	Average Summer Temperature	Average Autumn Maximum Temperature	Average Autumn Minimum Temperature	Average Autumn Temperature
89.7 F	70.3 F	80.0 F	76.7 F	55.8 F	66.62 F
Average Annual Temperature (based on 1981 to 2010 Climate Normals) is 64.5 F degrees.					

Table 3: The Average Seasonal and Annual Precipitation Totals Along With the Average Annual Total Amount of Snowfall for the Georgetown County Airport

Average Winter Precipitation Totals	Average Spring Precipitation Totals	Average Summer Precipitation Totals	Average Autumn Precipitation Totals	Average Annual Precipitation Totals	Average Annual Snowfall Totals
11.18 in	9.97 in	18.31 in	12.97 in	52.43 in	N/A in

Seasonal and Annual Wind Patterns Across the Georgetown mSA

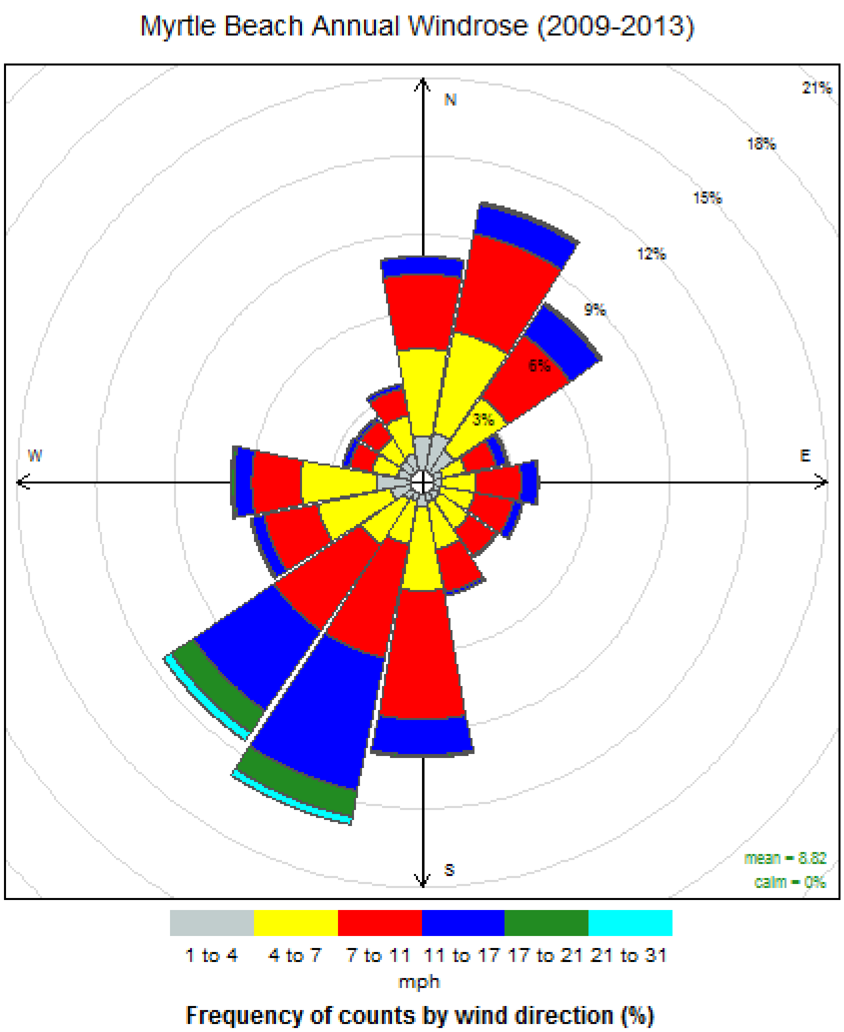
A series of windroses were created for the Georgetown mSA using the most representative meteorological station. Wind data from the Myrtle Beach area was used to represent the Georgetown mSA. The wind roses depict the five year wind direction and speeds for the northern coastal counties. The 2002-2006 annual wind rose for Georgetown shows that wind directions from the southwest and northeast are the most common. On an annual basis, the average wind speed is 6.30 knots with calm winds occurring 21 percent of the time.

The second wind rose represents wind patterns during the ozone season. Ozone season runs from April through October in the coastal counties of South Carolina. During this time, the dominant wind directions are from the northeast, south, and south-southwest. A southerly wind direction occurs more frequently during the ozone season due to the sea breeze front that develops during the warmer months. The average wind speed during ozone season is 6.48 knots with calm winds occurring nineteen percent of the time.

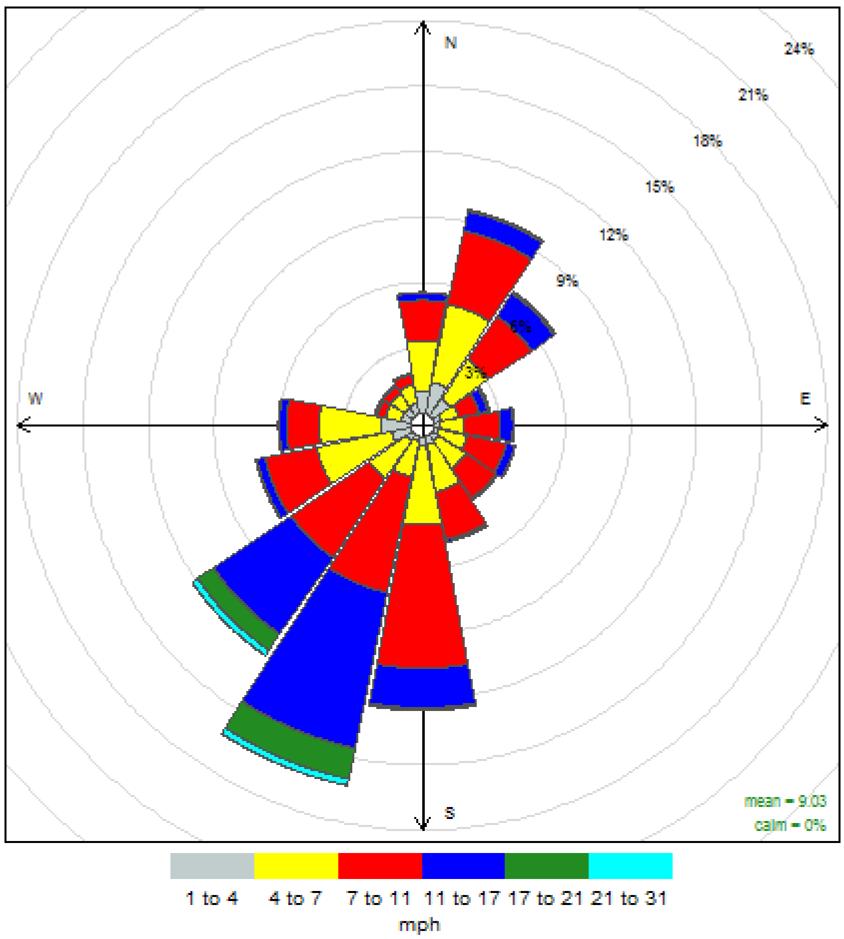
The next four wind roses represent the wind patterns during the four quarters that make up a year. January through March represents the first quarter, April through June represents the second quarter, the third quarter runs from July through September, and the fourth quarter runs begins in October and ends in December. During the first quarter, the wind pattern mirrors the annual wind pattern. Wind directions from the southwest and from the northeast are the most dominant directions from January through March. The average wind speed during the first quarter is 6.56 knots with calm winds occurring eighteen percent of the time. The second quarter windrose shows a much stronger southerly and south-southwesterly component to the wind than the other windroses. This southerly wind direction is the result of the sea breeze that develops during the warm months across the coastal areas of South Carolina. As the sea breeze pushes inland, a southerly flow off the ocean develops, and this generally keeps air quality cleaner the Georgetown area. The average wind speed during the second quarter is 7.01 knots with calm winds occurring only sixteen percent of the time. The third quarter wind rose shows dominant wind directions from the south, south-southwest, north-northeast, and from the northeast are common. Average wind speeds for the third quarter are 6.43 knots with calm winds occurring nineteen percent of the time.

Wind patterns during the fourth quarter are quite a bit different than the wind patterns during the other quarters. A north-northeasterly and northeasterly wind direction is most common from October through December. A more northerly and northeasterly wind direction shows up more often across much of South Carolina during the colder quarters. The average wind speed during the fourth quarter is 5.26 knots with calm winds occurring 28 percent of the time.

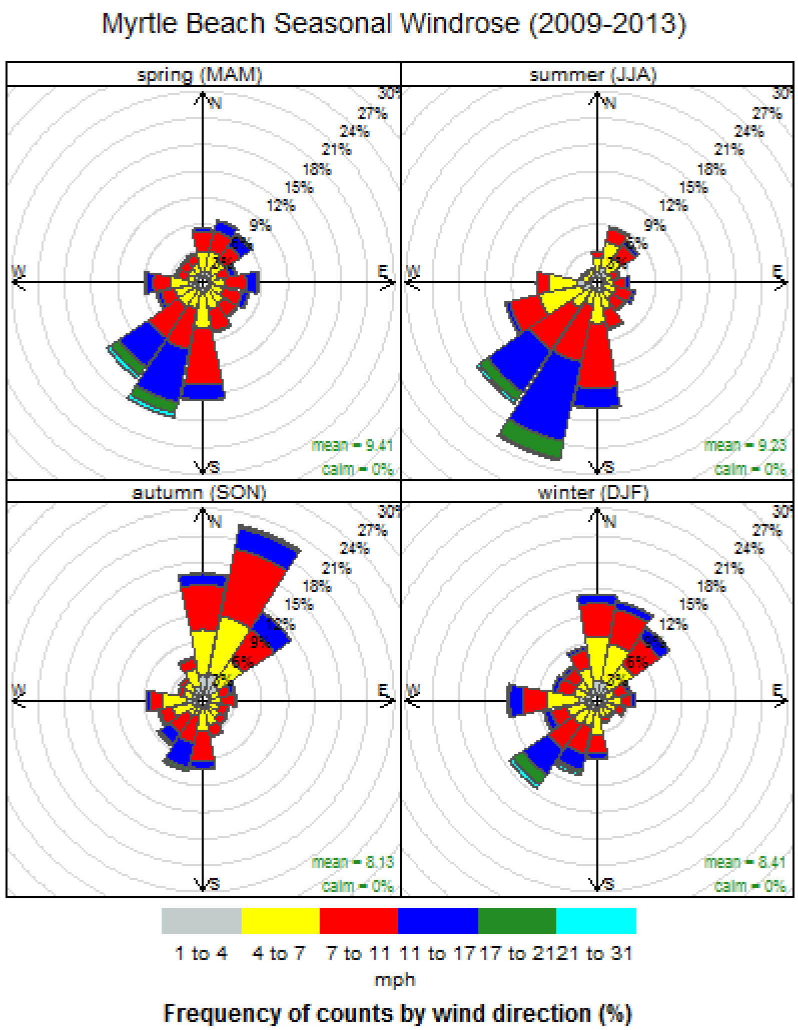
Annual & Seasonal Wind Roses for the Georgetown MSA Using the Columbia Florence Airport Wind Data



Myrtle Beach Ozone Season Windrose (2009-2013)



Frequency of counts by wind direction (%)


Myrtle Beach Seasonal Windrose (2009-2013)
spring (MAM)
summer (JJA)
autumn (SON)
winter (DJF)
N
S
E
W
30%
27%
24%
21%
18%
15%
12%
9%
6%
3%
mean = 9.41
calm = 0%
mean = 9.23
calm = 0%
mean = 8.13
calm = 0%
mean = 8.41
calm = 0%
1 to 4
4 to 7
7 to 11
11 to 17
17 to 21
21 to 31
mph
Frequency of counts by wind direction (%)

Seasonal and Annual Wind Patterns Across the Greenville MSA

Greenville MSA Meteorology and Climate

The Greenville area is located just south and east of the Appalachian Mountains. This area is frequently referred to as the Upstate of South Carolina. The Greenville County area's elevation above sea level is significantly higher than is the Midlands of South Carolina. The Greenville County area is represented by the National Weather Service office station known as Greer. Greer is located almost half way between the city of Greenville and Spartanburg. Meteorological conditions are a bit more temperate here than the more subtropical conditions across the Midlands and inland, coastal plains. Occasional cold spells can affect the area during the winter months; however, these cold spells a modified by the Appalachian Mountains located just north and west of the Greenville area. Chilly, wedge scenarios are common during the cooler months when high pressure, to the north, ridges down just east of the Appalachian Mountains. This pattern results in cloudy, chilly weather with drizzle and sometimes heavier precipitation is possible when weather systems approach from the west or southwest. Summers in the Greenville area are noticeably milder than the summers across the midlands of South Carolina. During the summer months when the Bermuda high is centered close to climatology, very warm weather is common across the Upstate with afternoon thunderstorms possible from time to time. When the Bermuda high is displace to the south and west of its normal position, hot and dry conditions often develop across the Upstate with little chances for afternoon thunderstorm activity. During these summers, drought can develop across the Upstate of South Carolina.

The Greenville-Spartanburg (Greer) airport climate data is used in Tables 1, 2, and 3 to represent the Greenville MSA. Table 1 shows the average winter and spring maximum and minimum temperatures at the Greenville-Spartanburg Airport for the period beginning in 1981 and ending in 2010. Table 2 shows the average summer and autumn maximum and minimum temperatures along with the average annual temperature across the Georgetown MSA. The average seasonal and annual precipitation totals are found in Table 3.

Georgetown County Airport Climate Normals

(Based on 1981-2010 Climate Data from NCDC)

Table 1: The Average Winter (Dec-Feb) and Spring (March-May) Temperatures for the Greenville-Spartanburg Airport

Average Winter Maximum Temperature	Average Winter Minimum Temperature	Average Winter Temperature	Average Spring Maximum Temperature	Average Spring Minimum Temperature	Average Spring Temperature
59.5 F	36.8 F	48.2 F	75.6 F	51.5 F	63.4 F

Table 2: The Average Summer (Jun-Aug) and Autumn (Sep-Nov) Temperatures Along With the Average Annual Temperature for the Greenville-Spartanburg Airport

Average Summer Maximum Temperature	Average Summer Minimum Temperature	Average Summer Temperature	Average Autumn Maximum Temperature	Average Autumn Minimum Temperature	Average Autumn Temperature
89.7 F	70.3 F	80.0 F	76.7 F	55.8 F	66.2 F
Average Annual Temperature (based on 1981 to 2010 Climate Normals) is 61.3 F degrees					

Table 3: The Average Seasonal and Annual Precipitation Totals for the Gaffney 6 E, SC station Along With the Average Annual Total Amount of Snowfall for the Greenville-Spartanburg Airport

Average Winter Precipitation Totals	Average Spring Precipitation Totals	Average Summer Precipitation Totals	Average Autumn Precipitation Totals	Average Annual Precipitation Totals	Average Annual Snowfall Totals
11.18 in	9.97 in	18.31 in	12.97 in	52.43 in	N/A

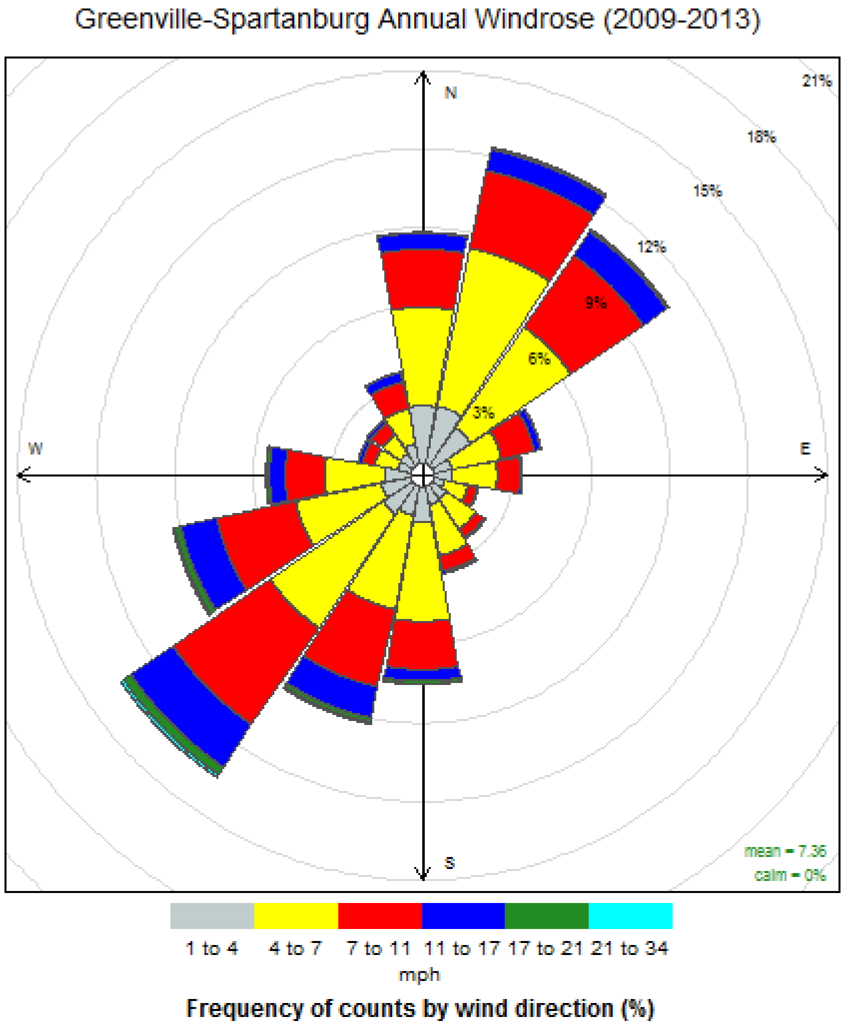
Annual & Seasonal Wind Roses for the Greenville MSA Using the Greenville-Spartanburg Airport Wind Data

Using the Greer weather station, a series of windroses was developed for the Upstate of South Carolina. The annual windrose represents wind patterns across the Upstate throughout the entire year. Dominant wind directions are from the southwest and from the northeast across the Upstate on an annual basis. These dominant southwesterly and northeasterly wind directions are partially due to the Appalachian Mountains that run from the northeast to the southwest, located just north and west of the Greenville area. It is easy to see how the wind patterns are parallel to the mountain range located just to the north and west. This mountain range helps to funnel the air flow from the southwest to northeast and from the northeast to southwest, depending on other meteorological conditions. The average annual wind speed across the Greenville area is 5.54 knots with calm winds occurring 19 percent of the time.

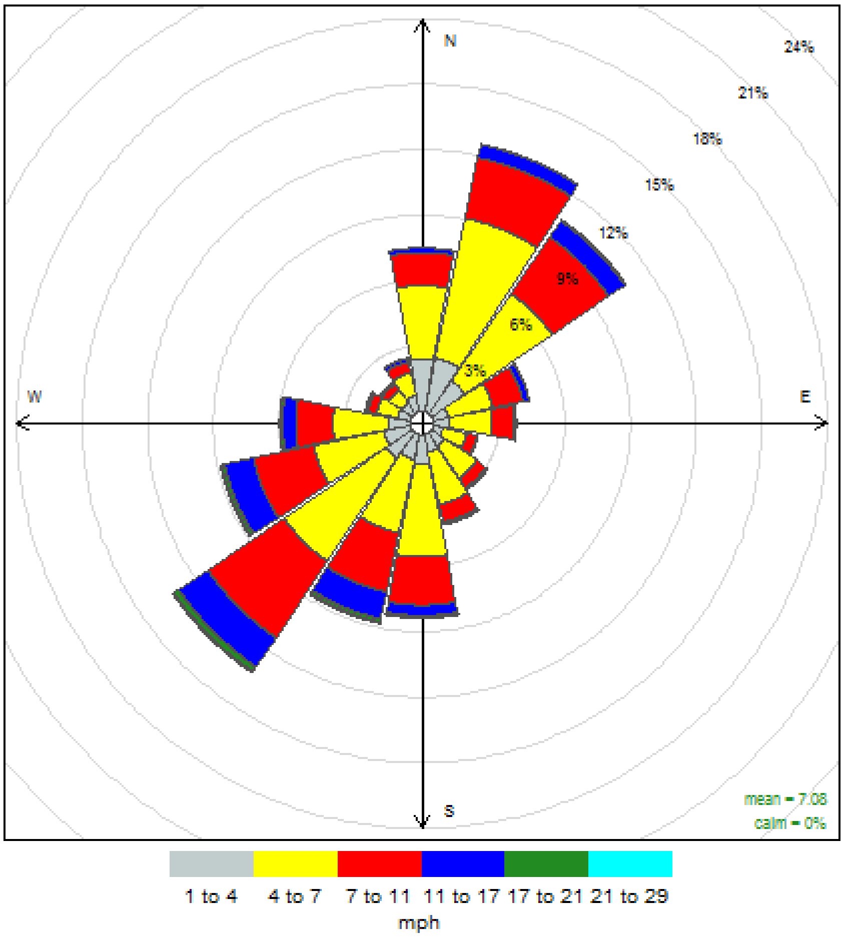
The next windrose represents the wind patterns during ozone season across the Upstate. Ozone season runs from April through October across the Upstate. Once again, the pattern that occurred during the annual time period shows up again for the ozone season. Southwesterly and northeasterly wind directions are dominant during ozone season. This results in ozone precursor transport from the Charlotte and Atlanta areas into the Upstate of South Carolina throughout ozone season. The average wind speed from April through October is 5.21 knots with calm winds representing twenty percent of the wind speeds.

The next four windroses represents each quarter during the year. The first quarter runs from January through March, the second quarter runs from April through June, the third quarter runs from July through September, and the fourth quarter runs from October through December. The first quarter windrose indicates no surprises. Just as with the annual and ozone windroses, the first quarter windrose shows an even more extreme southwest to northeast or northeast to southwest flow across the Upstate. The average wind speed during the first quarter is 6.42 knots with calm winds occurring only fifteen percent of the time. During the second quarter, the dominant wind directions are once again skewed by the Appalachian Mountains. Dominant wind directions from the southwest to northeast or northeast to southwest again prevail across the Upstate. The average wind speed during the second quarter is 5.83 knots with calm winds occurring seventeen percent of the time. The third quarter windrose shows a somewhat different wind pattern than the first four windroses. Dominant wind directions are from the north-northeast and northeast with the southwesterly wind direction being quite a bit less dominant. This is due to the northeasterly bias that occurs throughout much of South Carolina during the latter half of the third quarter, especially during the month of September. This north-northeasterly and northeasterly wind is even more common in the Upstate due to the southwest to northeasterly running Appalachian Mountains. The average wind speed during the third quarter is the lowest wind speed for any quarter, at 4.65 knots. Calm winds make up 23 percent of the wind speeds during the third quarter. This is the largest amounts of calms of any quarter.

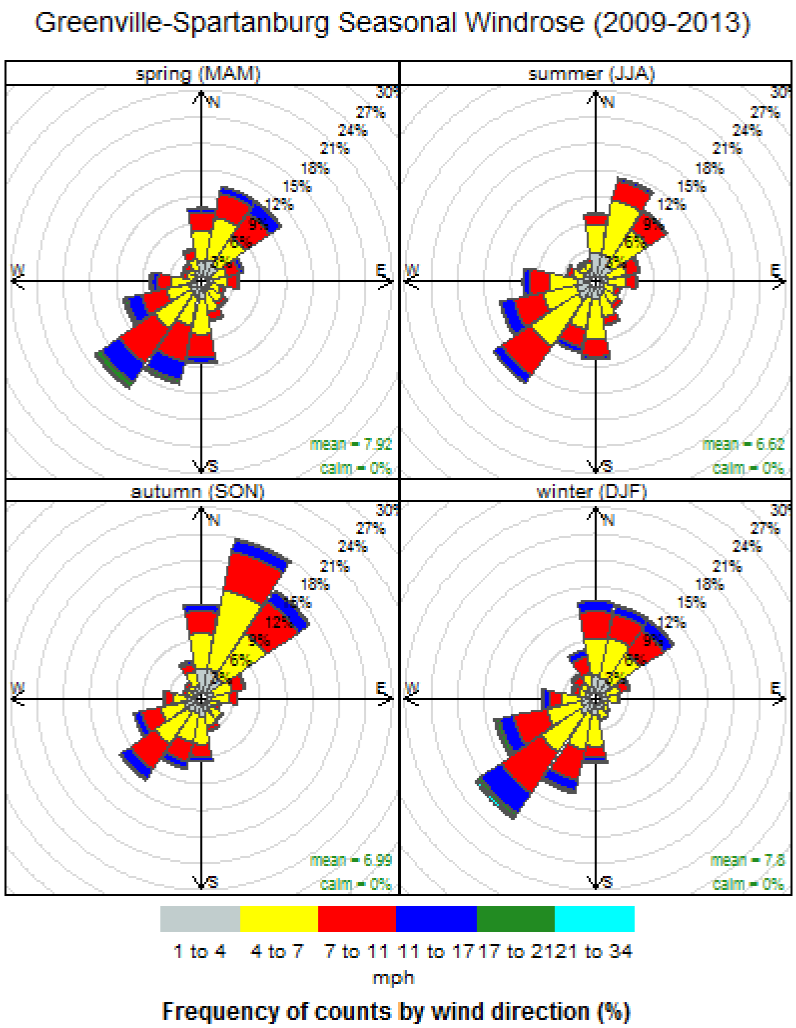
The fourth quarter also shows the most dominant wind direction being from the north-northeast and from the northeast with a secondary, smaller maximum occurring from the southwest. The average wind speed for the fourth quarter is 5.29 knots with calms occurring 21 percent of the time.



Greenville-Spartanburg Ozone Season Windrose (2009-2013)



Frequency of counts by wind direction (%)



Greenville-Spartanburg Seasonal Windrose (2009-2013)
spring (MAM)
summer (JJA)
autumn (SON)
winter (DJF)
N
E
S
W
mean = 7.92
calm = 0%
mean = 6.62
calm = 0%
mean = 6.99
calm = 0%
mean = 7.8
calm = 0%
1 to 4
4 to 7
7 to 11
11 to 17
17 to 21
21 to 34
mph
Frequency of counts by wind direction (%)

Seneca mSA Meteorology and Climate

The Seneca area is located just south and east of the Appalachian Mountains. This area is frequently referred to as the Upstate of South Carolina. Seneca area's elevation above sea level is significantly higher than is the Midlands of South Carolina. The Seneca area is represented by the National Weather Service office station known as Greer. Greer is located almost half way between the city of Greenville and Spartanburg. Meteorological conditions are a bit more temperate here than the more subtropical conditions across the Midlands and inland, coastal plains. Occasional cold spells can affect the area during the winter months; however, these cold spells are modified by the Appalachian Mountains located just north and west of the Greenville area. Chilly, wedge scenarios are common during the cooler months when high pressure, to the north, ridges down just east of the Appalachian Mountains. This pattern results in cloudy, chilly weather with drizzle and sometimes heavier precipitation possible when weather systems approach from the west or southwest. Summers in the Seneca area are noticeably milder than the summers across the Midlands of South Carolina. During the summer months, when the Bermuda high is centered close to climatology, very warm weather is common across the Upstate with afternoon thunderstorms possible from time to time. When the Bermuda high is displaced to the south and west of its normal position, hot and dry conditions often develop across the Upstate with little chances for afternoon thunderstorm activity. During these summers, drought can develop across the Upstate of South Carolina. Elevated ozone concentrations are generally more common during these hot and dry summers.

The Anderson County airport climate data is used in Tables 1, 2, and 3 to represent Anderson County. Table 1 shows the average winter and spring maximum and minimum temperatures at the Anderson County Airport for the period beginning in 1981 and ending in 2010. Table 2 shows the average summer and autumn maximum and minimum temperatures along with the average annual temperature across at the Anderson County Airport. The average seasonal and annual precipitation totals are found in Table 3.

Anderson County Airport Climate Normals

(Based on 1981-2010 Climate Data from NCDC)

Table 1: The Average Winter (Dec-Feb) and Spring (March-May) Temperatures for the Anderson County Airport Site, SC

Average Winter Maximum Temperature	Average Winter Minimum Temperature	Average Winter Temperature	Average Spring Maximum Temperature	Average Spring Minimum Temperature	Average Spring Temperature
55.1 F	33.0 F	44.0 F	73.1 F	49.1 F	61.1 F

Table 2: The Average Summer (Jun-Aug) and Autumn (Sep-Nov) Temperatures Along With the Average Annual temperature for the Anderson County Airport Site, SC

Average Summer Maximum Temperature	Average Summer Minimum Temperature	Average Summer Temperature	Average Autumn Maximum Temperature	Average Autumn Minimum Temperature	Average Autumn Temperature
89.7 F	68.9 F	79.3 F	73.9 F	51.5 F	62.7 F
Average Annual Temperature (based on 1981 to 2010 Climate Normals) is 61.8 F degrees.					

Table 3: The Average Seasonal and Annual Precipitation Totals, Along With the Average Annual Snowfall Totals for the Greenville-Spartanburg Airport, SC

Average Winter Precipitation Totals	Average Spring Precipitation Totals	Average Summer Precipitation Totals	Average Autumn Precipitation Totals	Average Annual Precipitation Totals	Average Annual Snowfall Totals
13.98 in	10.91 in	11.77 in	11.70 in	48.36 in	4.7 in

Seasonal and Annual Wind Patterns Across the Seneca mSA Using Greenville-Spartanburg Airport Meteorological Data

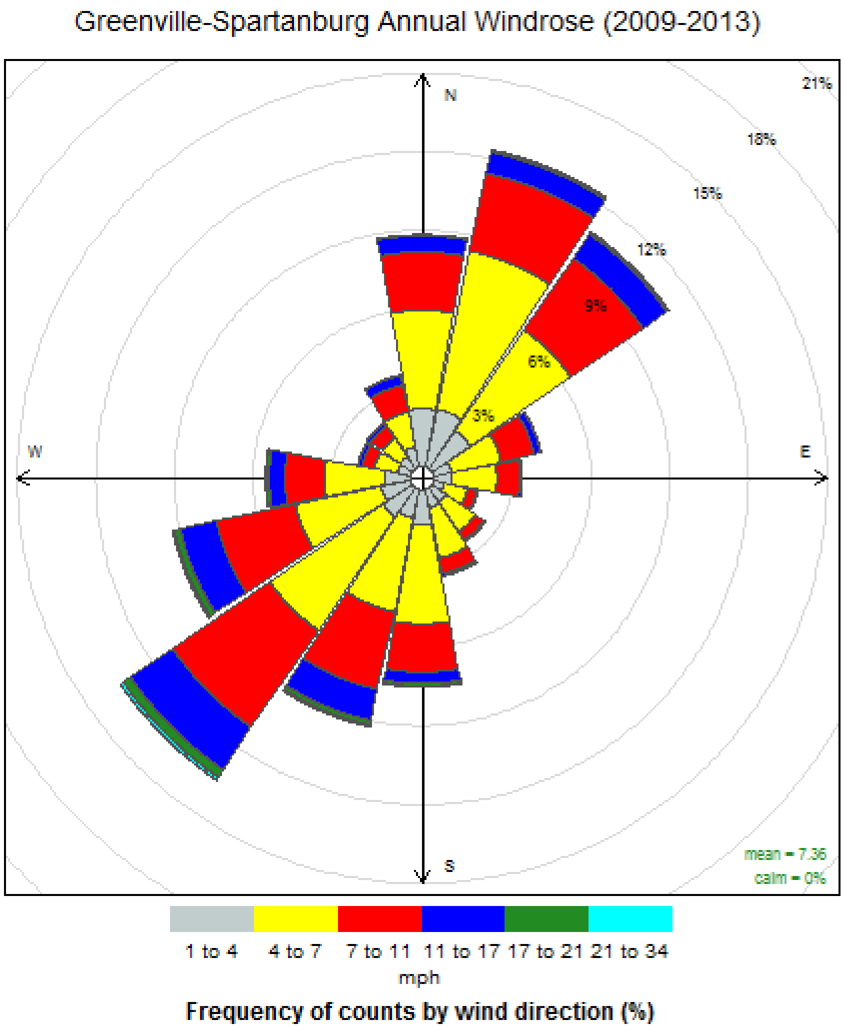
Using the Greer weather station, a series of windroses was developed for the Upstate of South Carolina. The annual windrose represents wind patterns across the Upstate throughout the entire year. Dominant wind directions are from the southwest and from the northeast across the Upstate on an annual basis. These dominant southwesterly and northeasterly wind directions are partially due to the Appalachian Mountains that run from the northeast to the southwest, located just north and west of the Greenville area. It is easy to see how the wind patterns are parallel to the mountain range located just to the north and west. This mountain range helps to funnel the air flow from the southwest to northeast and from the northeast to southwest, depending on other meteorological conditions. The average annual wind speed across the Seneca area is 5.54 knots with calm winds occurring 19 percent of the time.

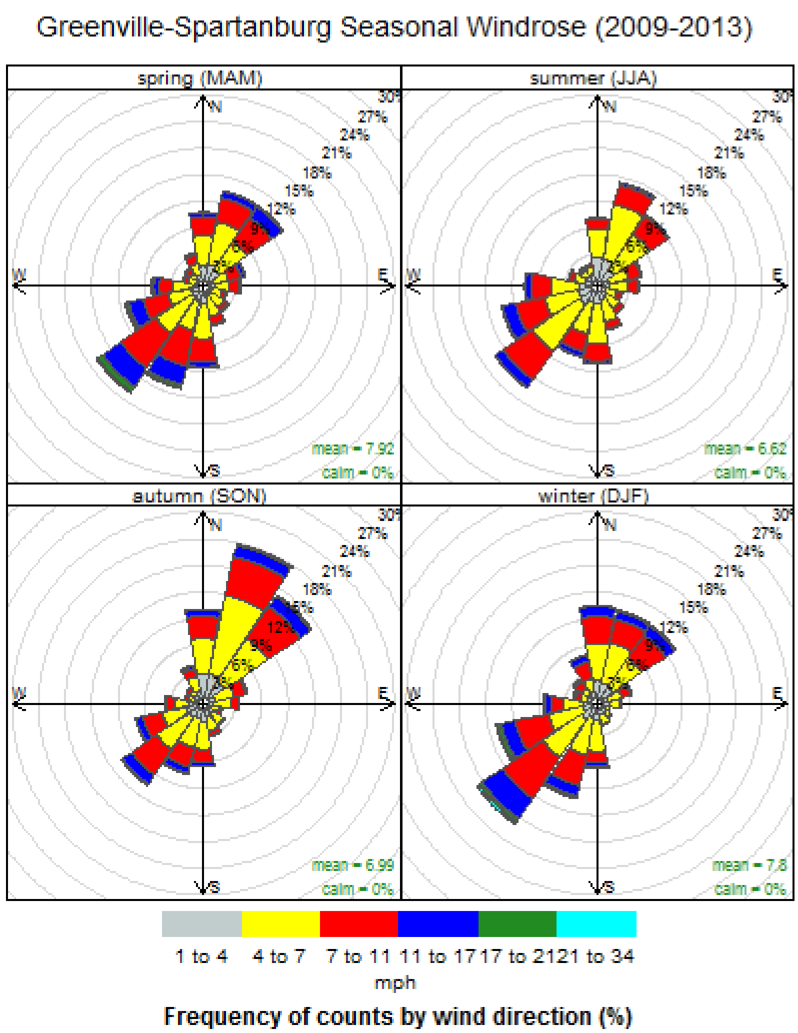
The next windrose represents the wind patterns during ozone season across the Upstate. Ozone season runs from April through October across the Upstate. Once again, the pattern that occurred during the annual time period shows up again for the ozone season. Southwesterly and northeasterly wind directions are dominant during ozone season. This results in ozone precursor transport from the Charlotte and Atlanta areas into the Upstate of South Carolina throughout ozone season. The average wind speed from April through October is 5.21 knots with calm winds representing twenty percent of the wind speeds.

The next four windroses represents each quarter during the year. The first quarter runs from January through March, the second quarter runs from April through June, the third quarter runs from July through September, and the fourth quarter runs from October through December. The first quarter windrose indicates no surprises. Just as with the annual and ozone windroses, the first quarter windrose shows an even more extreme southwest to northeast or northeast to southwest flow across the Upstate. The average wind speed during the first quarter is 6.42 knots with calm winds occurring only fifteen percent of the time. During the second quarter, the dominant wind directions are again skewed by the Appalachian Mountains. Dominant wind directions from the southwest to northeast or northeast to southwest again prevail across the Upstate. The average wind speed during the second quarter is 5.83 knots with calm winds occurring seventeen percent of the time. The third quarter windrose shows a somewhat different wind pattern than the first four windroses. Dominant wind directions are from the north-northeast and northeast with the southwesterly wind direction being quite a bit less common. This is due to the northeasterly bias that occurs throughout much of South Carolina during the latter half of the third quarter, especially during the month of September. This north-northeasterly and northeasterly wind is even more common in the Upstate due to the southwest to northeasterly running Appalachian Mountains. The average wind speed during the third quarter is the lowest wind speed for any quarter, at 4.65 knots. Calm winds make up 23 percent of the wind speeds during the third quarter. This is the largest amounts of calms of any quarter.

The fourth quarter also shows the most dominant wind direction being from the north-northeast and from the northeast with a secondary, smaller maximum occurring from the southwest. The average wind speed for the fourth quarter is 5.29 knots with calms occurring 21 percent of the time.

Annual & Seasonal Wind Roses for the Seneca mSA Using the Greenville-Spartanburg Airport Meteorological Data




Greenville-Spartanburg Seasonal Windrose (2009-2013)
spring (MAM)
summer (JJA)
autumn (SON)
winter (DJF)
N
E
S
W
mean = 7.92
calm = 0%
mean = 6.62
calm = 0%
mean = 6.99
calm = 0%
mean = 7.8
calm = 0%
1 to 4
4 to 7
7 to 11
11 to 17
17 to 21
21 to 34
mph
Frequency of counts by wind direction (%)

Seasonal and Annual Wind Patterns Across the Spartanburg MSA Using Greenville-Spartanburg Airport Meteorological Data

Spartanburg MSA Meteorology and Climate

The Spartanburg area is located just south and east of the Appalachian Mountains. This area is frequently referred to as the Upstate of South Carolina. The Spartanburg County area's elevation above sea level is significantly higher than is the Midlands of South Carolina. The Spartanburg County area is represented by the National Weather Service office station known as Greer. Greer is located almost half way between the cities of Greenville and Spartanburg. Meteorological conditions are a bit more temperate here than the more subtropical conditions across the Midlands and inland, coastal plains. Occasional cold spells can affect the area during the winter months; however, these cold spells are modified by the Appalachian Mountains located just north and west of the Spartanburg area. Chilly, wedge scenarios are common during the cooler months when high pressure to the north ridges down just east of the Appalachian Mountains. This pattern results in cloudy, chilly weather with drizzle and sometimes heavier precipitation possible when weather systems approach from the west or southwest. Summers in the Spartanburg area are noticeably milder than the summers across the Midlands of South Carolina. During the summer months when the Bermuda high is centered close to climatology, very warm weather is common across the Upstate with afternoon thunderstorms possible from time to time. When the Bermuda high is displace to the south and west of its normal position, hot and dry conditions often develop across the Upstate with little chances for afternoon thunderstorm activity. During these summers, drought can develop across the Upstate of South Carolina.

The Spartanburg 3 SSE site's climate data is used in Tables 1, 2, and 3 to represent Spartanburg MSA. Table 1 shows the average winter and spring maximum and minimum temperatures at the Anderson County Airport for the period beginning in 1981 and ending in 2010. Table 2 shows the average summer and autumn maximum and minimum temperatures along with the average annual temperature across at the Spartanburg 3 SSE site. The average seasonal and annual precipitation totals are found in Table 3.

Spartanburg 3 SSE Climate Normals

(*Based on 1981-2010 Climate Data from NCDC)*

Table 1: The Average Winter (Dec-Feb) and Spring (March-May) Temperatures for the Spartanburg 3 SSE, SC

Average Winter Maximum Temperature	Average Winter Minimum Temperature	Average Winter Temperature	Average Spring Maximum Temperature	Average Spring Minimum Temperature	Average Spring Temperature
56.5 F	30.9 F	43.7 F	75.0 F	45.6 F	60.3 F

Table 2: The Average Summer (Jun-Aug) and Autumn (Sep-Nov) Temperatures Along With the Spartanburg 3 SSE, SC

Average Summer Maximum Temperature	Average Summer Minimum Temperature	Average Summer Temperature	Average Autumn Maximum Temperature	Average Autumn Minimum Temperature	Average Autumn Temperature
89.8 F	65.6 F	77.7 F	74.8 F	48.0 F	61.4 F
Average Annual Temperature (based on 1981 to 2010 Climate Normals) is 60.8 F degrees.					

Table 3: The Average Seasonal and Annual Precipitation Totals, Along With the average Annual snowfall totals for Spartanburg 3 SSW, SC

Average Winter Precipitation Totals	Average Spring Precipitation Totals	Average Summer Precipitation Totals	Average Autumn Precipitation Totals	Average Annual Precipitation Totals	Average Annual Snowfall Totals
12.65 in	11.91 in	12.72 in	11.13 in	48.41 in	4.7 in

Seasonal and Annual Wind Patterns Across the Spartanburg MSA Using Greenville-Spartanburg Airport Meteorological Data

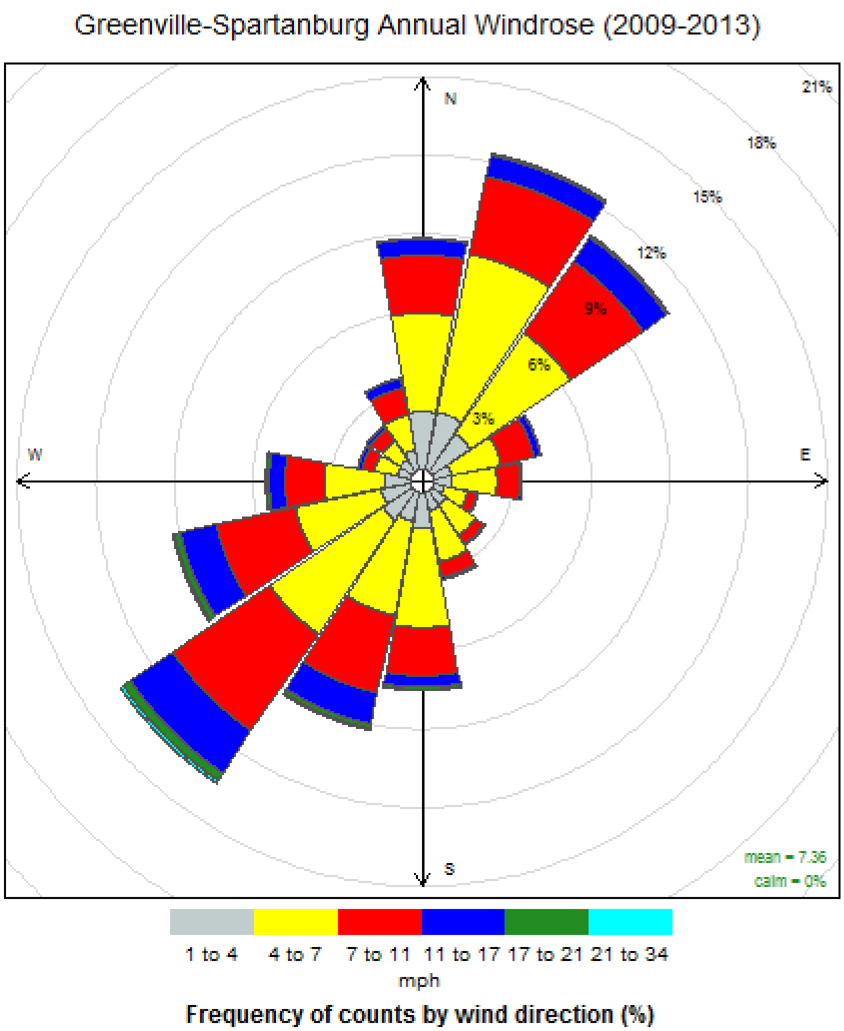
Using the Greer weather station, a series of windroses was developed for the Upstate of South Carolina. The annual windrose represents wind patterns across the Upstate throughout the entire year. Dominant wind directions are from the southwest and from the northeast across the Upstate on an annual basis. These dominant southwesterly and northeasterly wind directions are partially due to the Appalachian Mountains that run from the northeast to the southwest, located just north and west of the Spartanburg area. It is easy to see how the wind patterns are parallel to the mountain range located just to the north and west. This mountain range helps to funnel the air flow from the southwest to northeast and from the northeast to southwest, depending on other meteorological conditions. The average annual wind speed across the Spartanburg area is 5.54 knots with calm winds occurring nineteen percent of the time.

The next windrose represents the wind patterns during ozone season across the Upstate. Ozone season runs from April through October across the Upstate. Once again, the pattern that occurred during the annual time period shows up again for the ozone season. Southwesterly and northeasterly wind directions are dominant during Ozone season. This results in Ozone precursor transport from the Charlotte and Atlanta areas into the Upstate of South Carolina throughout Ozone season. The average wind speed from April through October is 5.21 knots with calm winds representing twenty percent of the wind speeds.

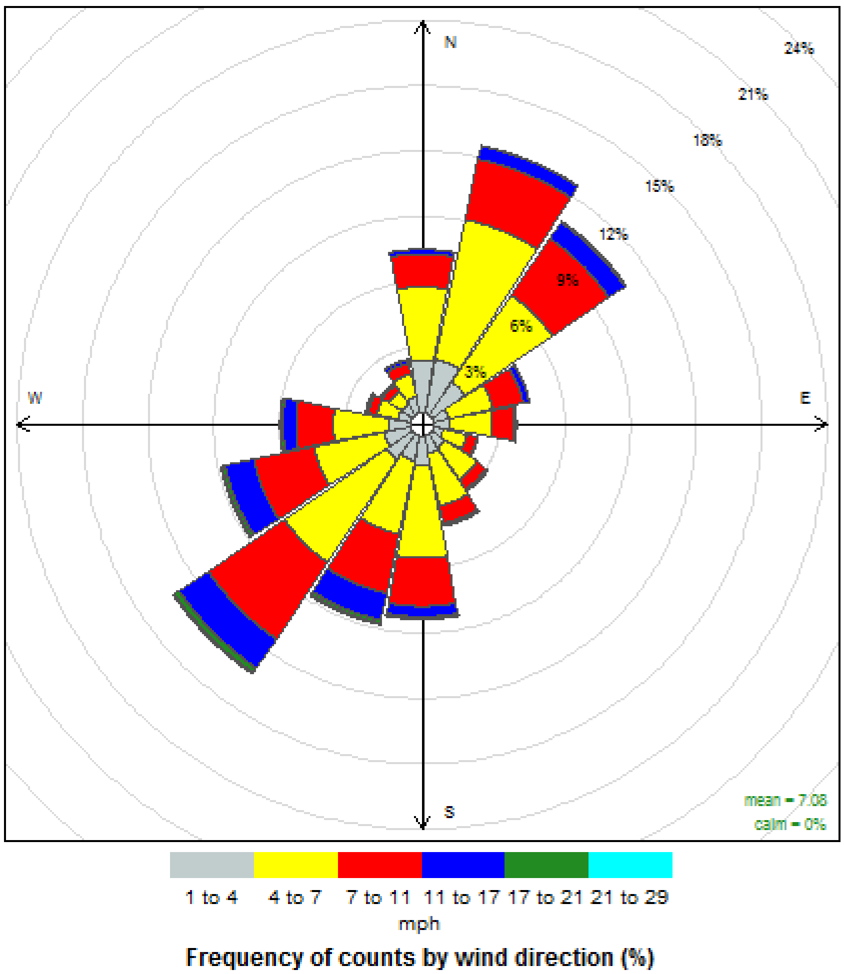
The next four windroses represents each quarter during the year. The first quarter runs from January through March, the second quarter runs from April through June, the third quarter runs from July through September, and the fourth quarter runs from October through December. The first quarter windrose indicates no surprises. Just as with the annual and ozone windroses, the first quarter windrose shows an even more extreme southwest to northeast or northeast to southwest flow across the Upstate. The average wind speed during the first quarter is 6.42 knots with calm winds occurring only fifteen percent of the time. During the second quarter, the dominant wind directions are once again skewed by the Appalachian Mountains. Dominant wind directions from the southwest to northeast or northeast to southwest again prevail across the Upstate. The average wind speed during the second quarter is 5.83 knots with calm winds occurring seventeen percent of the time. The third quarter windrose shows a somewhat different wind pattern than the first four windroses. Dominant wind directions are from the north-northeast and northeast with the southwesterly wind direction being quite a bit less dominant. This is due to the northeasterly bias that occurs throughout much of South Carolina during the latter half of the third quarter, especially during the month of September. This north-northeasterly and northeasterly wind is even more common in the Upstate due to the southwest to northeasterly running Appalachian Mountains. The average wind speed during the third quarter is the lowest wind speed for any quarter, at 4.65 knots. Calm winds make up 23.08 percent of the wind speeds during the third quarter.

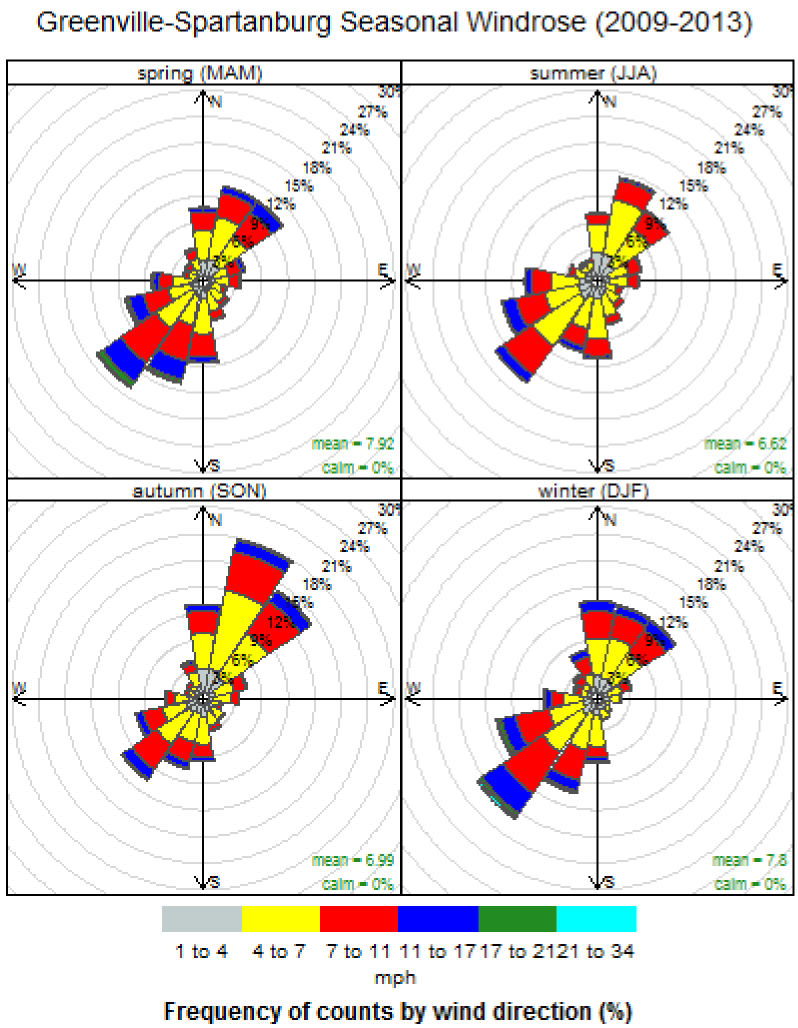
This is the largest amounts of calms of any quarter. The fourth quarter also shows the most dominant wind direction being from the north-northeast and from the northeast with a secondary, smaller maximum occurring from the southwest. The average wind speed for the fourth quarter is 5.29 knots with calms occurring 21 percent of the time.

Annual & Seasonal Wind Roses for the Seneca MSA Using the Greenville-Spartanburg Airport Meteorological Data



Greenville-Spartanburg Ozone Season Windrose (2009-2013)



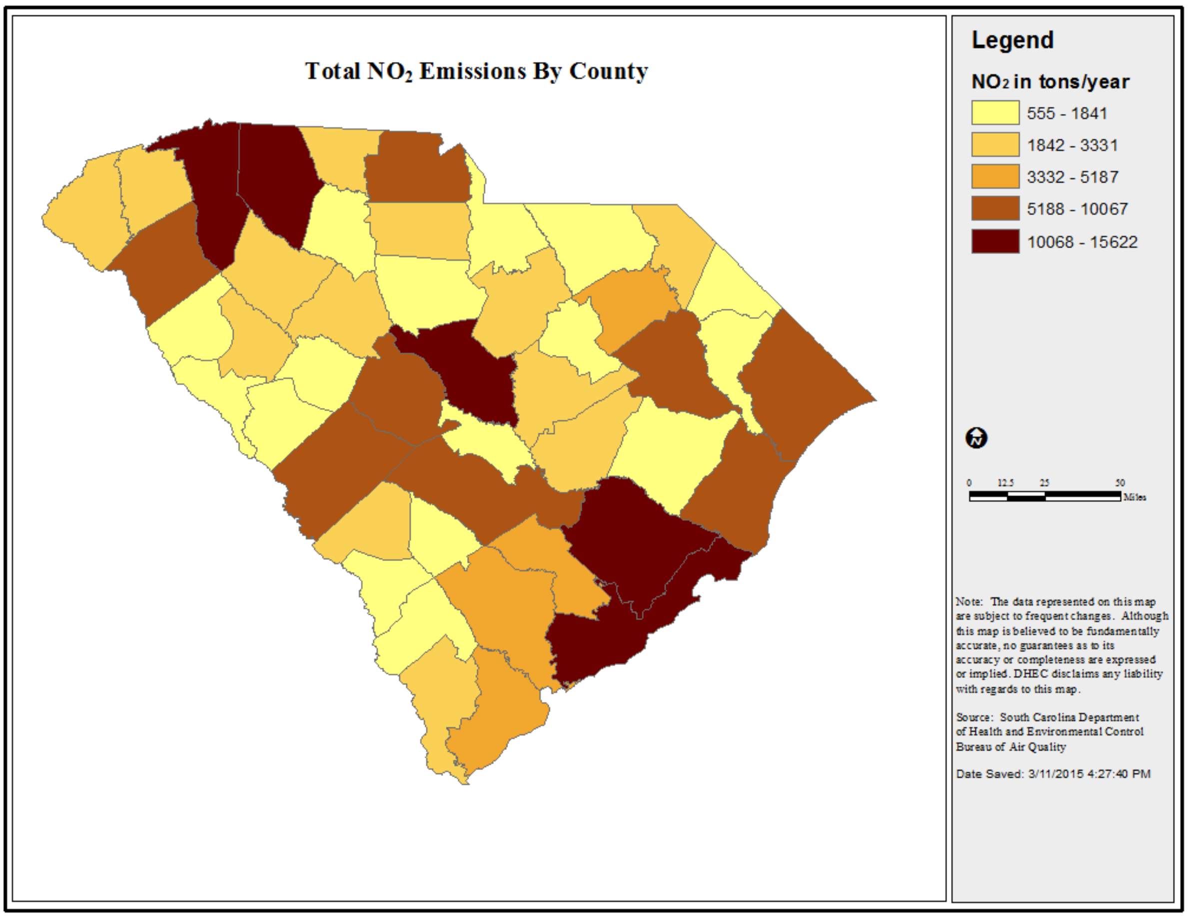


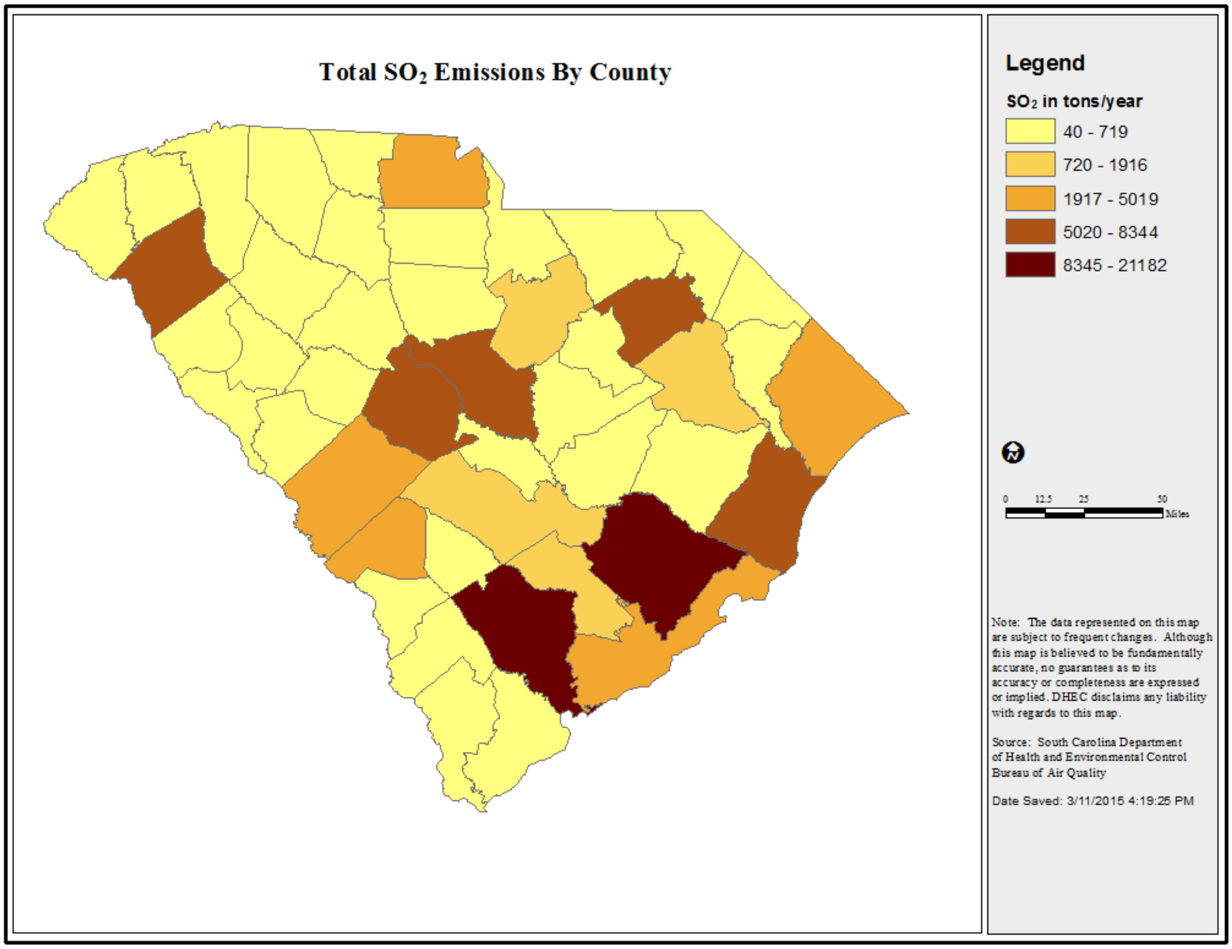
Greenville-Spartanburg Seasonal Windrose (2009-2013)
spring (MAM)
summer (JJA)
autumn (SON)
winter (DJF)
N
E
S
W
mean = 7.92
calm = 0%
mean = 6.62
calm = 0%
mean = 6.99
calm = 0%
mean = 7.8
calm = 0%
1 to 4
4 to 7
7 to 11
11 to 17
17 to 21
21 to 34
mph
Frequency of counts by wind direction (%)

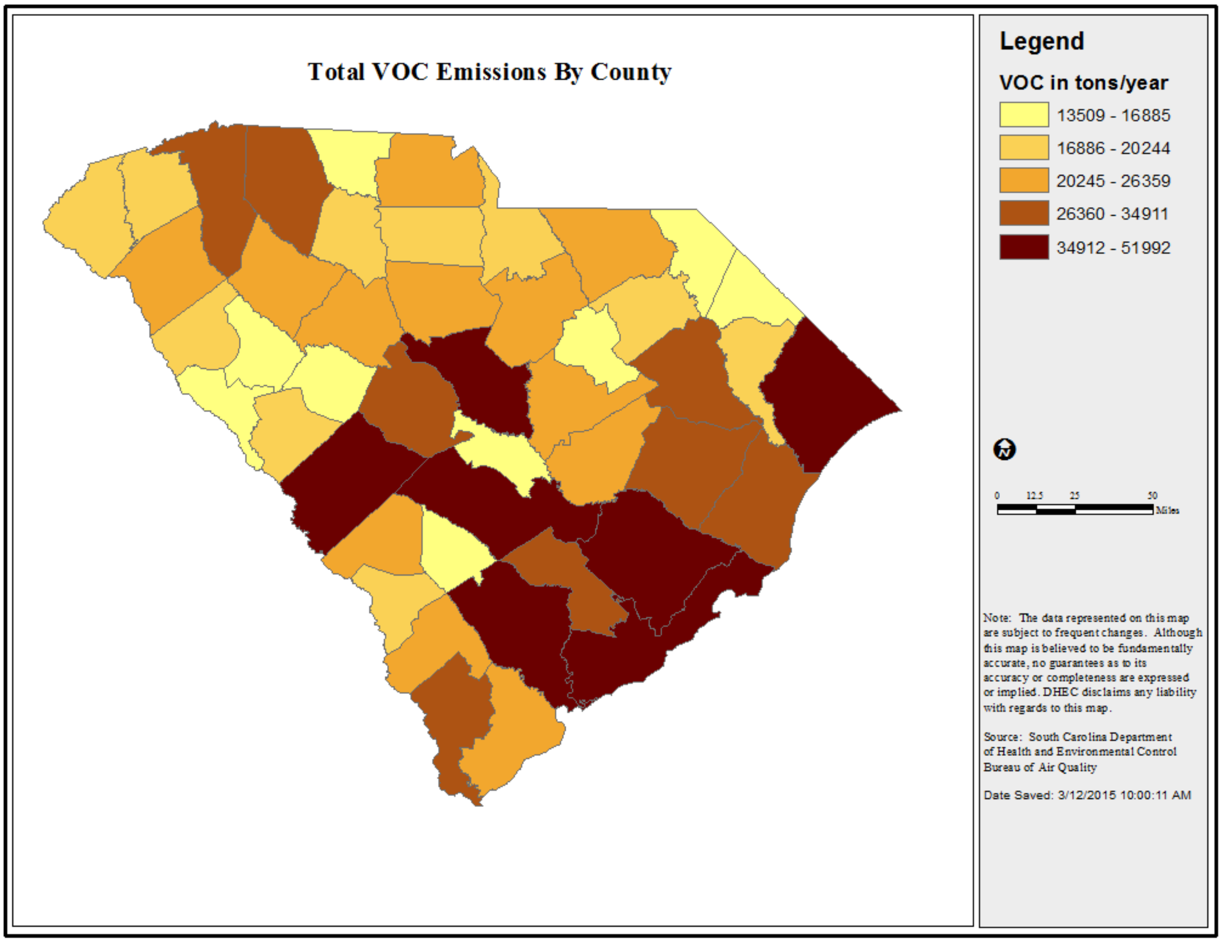
Appendix E: Detailed emissions data

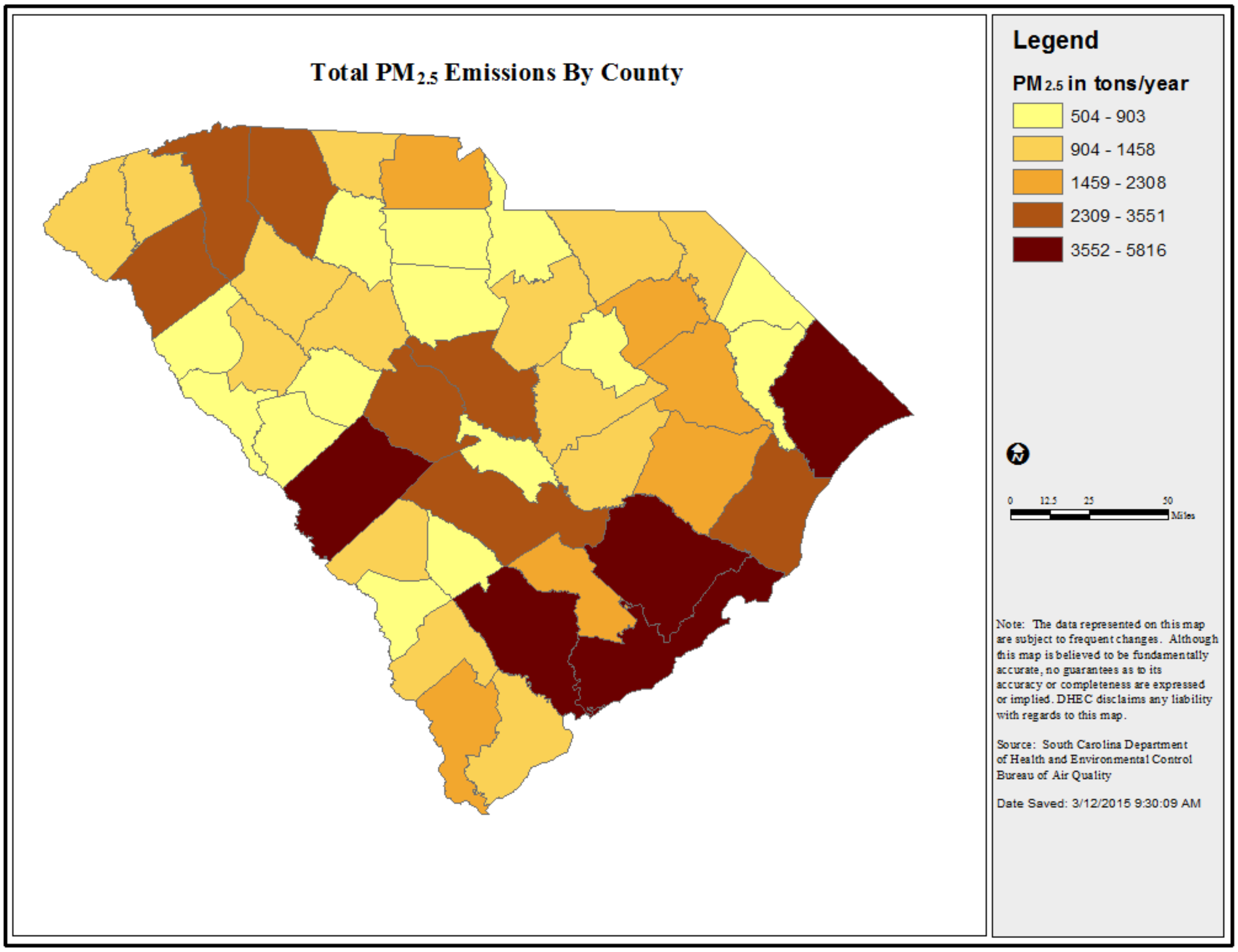
The maps below show the total emissions for VOC, SO_2, NO_2, CO, Lead, PM_{10} and $PM_{2.5}$ on a county-wide basis. These maps include emissions from point, area, mobile, biogenic and non-road sources. On-road mobile sources of pollution include most forms of transportation such as automobiles, trucks, and buses. Non-road mobile sources include a wide variety of internal combustion engines not associated with highway vehicles. Examples of non-road mobile sources would be construction equipment, lawn mowers, and boats. A point source of pollution refers to a source at a fixed point, such as an industrial boiler or storage tank, that emits air pollutants. An area source refers to a series of small sources that together can affect air quality in a region. Examples of area sources include gas stations and residential heaters. Biogenic emissions are emissions that originate from natural sources such as vegetation.

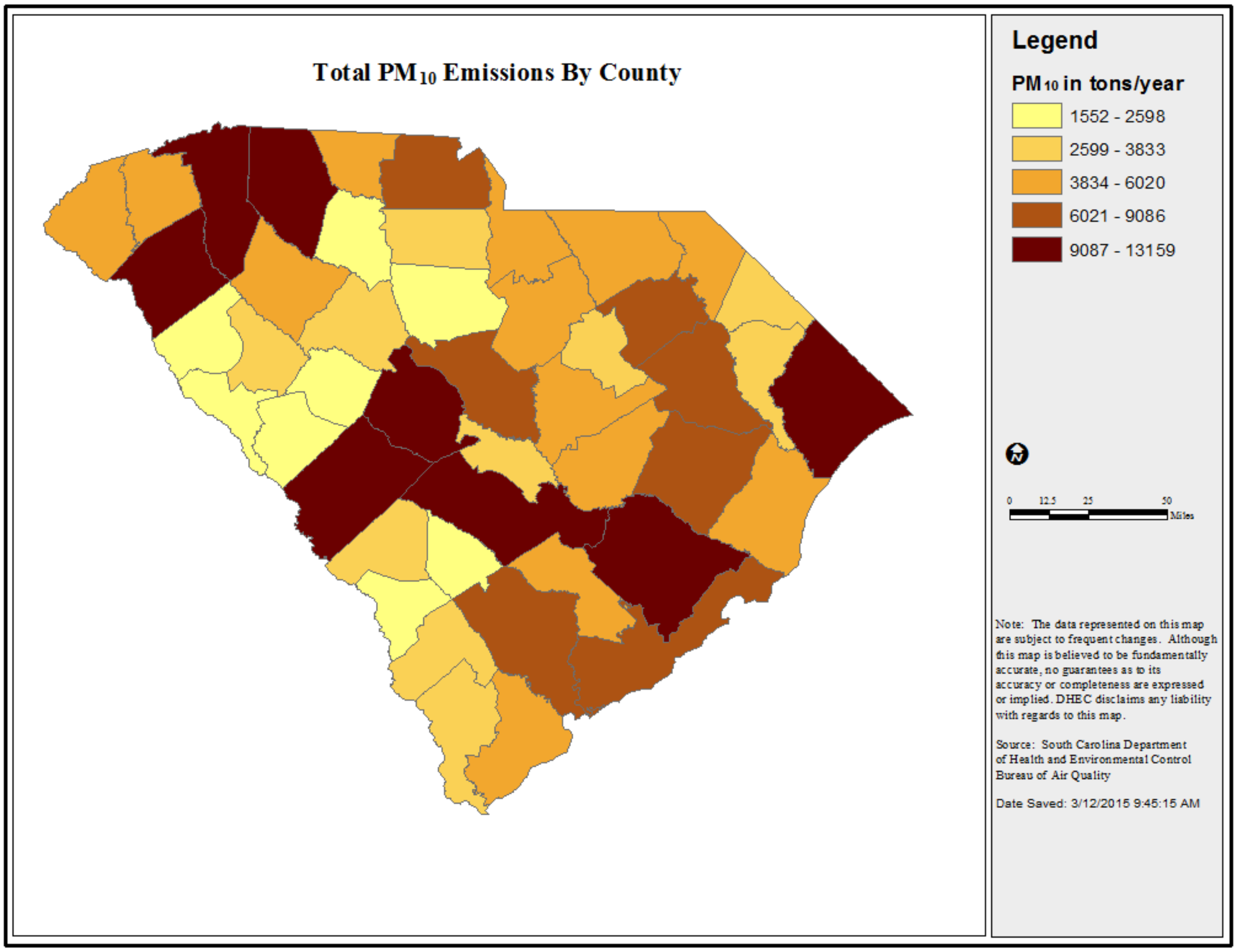
Total emissions tend to be highest in those counties with higher populations where a large number of motor vehicles and facilities are located than in more rural counties.

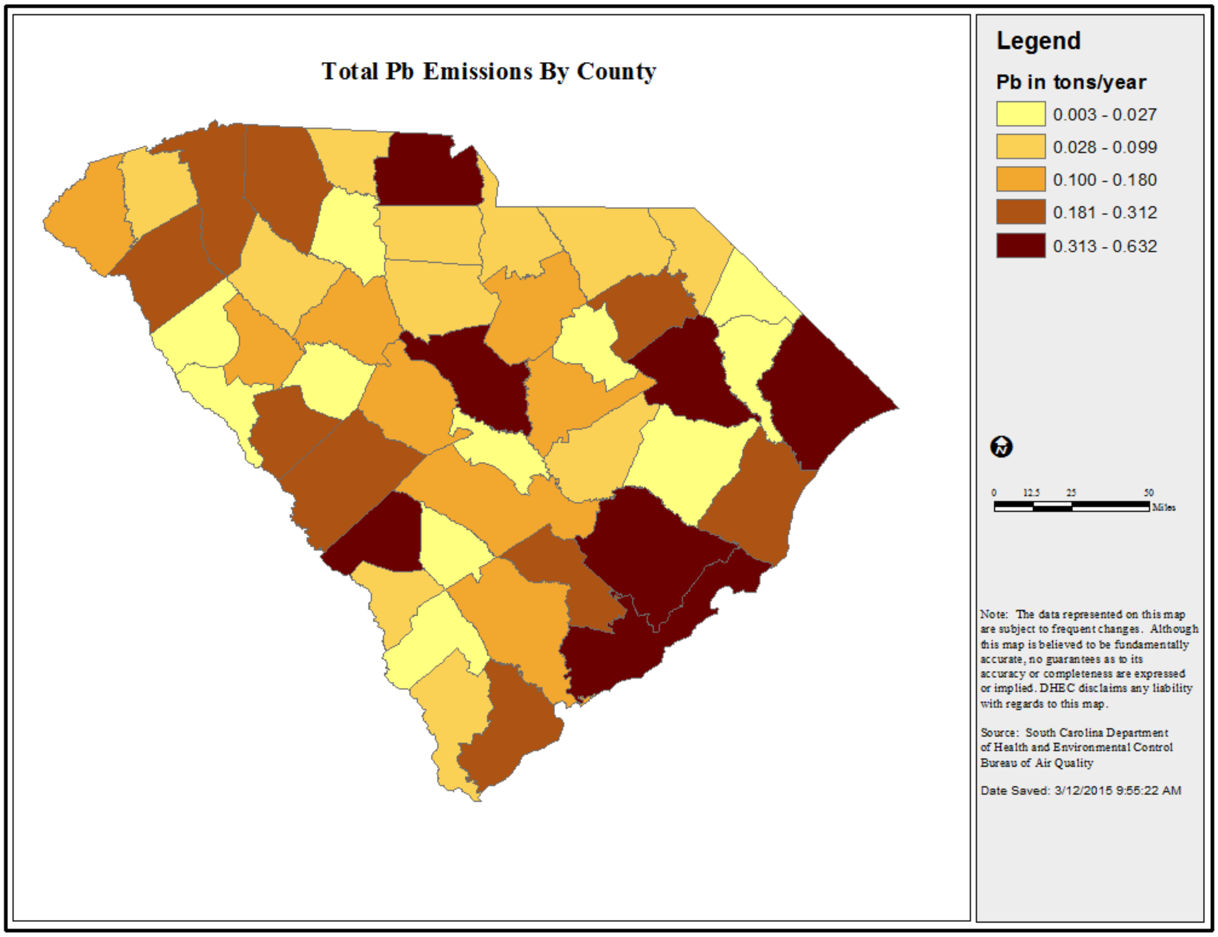



Total SO_2 Emissions By County
Legend
SO_2 in tons/year
40 - 719
720 - 1916
1917 - 5019
5020 - 8344
8345 - 21182
0 12.5 25 50 Miles
Note: The data represented on this map are subject to frequent changes. Although this map is believed to be fundamentally accurate, no guarantees as to its accuracy or completeness are expressed or implied. DHEC disclaims any liability with regards to this map.
Source: South Carolina Department of Health and Environmental Control Bureau of Air Quality
Date Saved: 3/11/2015 4:19:25 PM


Total VOC Emissions By County
Legend
VOC in tons/year
13509 - 16885
16886 - 20244
20245 - 26359
26360 - 34911
34912 - 51992
N
0
12.5
25
50
Miles
Note: The data represented on this map are subject to frequent changes. Although this map is believed to be fundamentally accurate, no guarantees as to its accuracy or completeness are expressed or implied. DHEC disclaims any liability with regards to this map.
Source: South Carolina Department of Health and Environmental Control Bureau of Air Quality
Date Saved: 3/12/2015 10:00:11 AM


Total $PM_{2.5}$ Emissions By County
Legend
$PM_{2.5}$ in tons/year
504 - 903
904 - 1458
1459 - 2308
2309 - 3551
3552 - 5816
0 12.5 25 50
Miles
Note: The data represented on this map are subject to frequent changes. Although this map is believed to be fundamentally accurate, no guarantees as to its accuracy or completeness are expressed or implied. DHEC disclaims any liability with regards to this map.
Source: South Carolina Department of Health and Environmental Control Bureau of Air Quality
Date Saved: 3/12/2015 9:30:09 AM

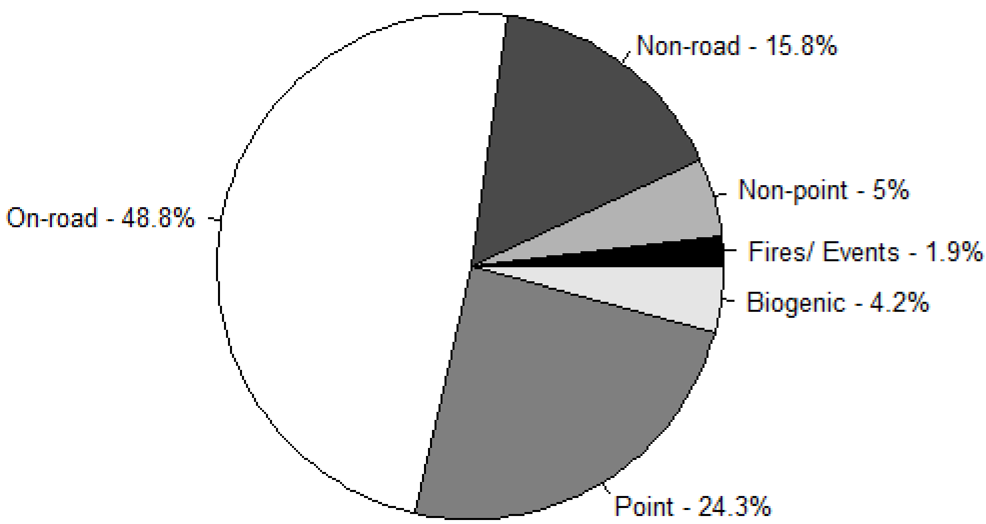

Total PM_{10} Emissions By County
Legend
PM_{10} in tons/year
1552 - 2598
2599 - 3833
3834 - 6020
6021 - 9086
9087 - 13159
0
12.5
25
50
Miles
Note: The data represented on this map are subject to frequent changes. Although this map is believed to be fundamentally accurate, no guarantees as to its accuracy or completeness are expressed or implied. DHEC disclaims any liability with regards to this map.
Source: South Carolina Department of Health and Environmental Control Bureau of Air Quality
Date Saved: 3/12/2015 9:45:15 AM



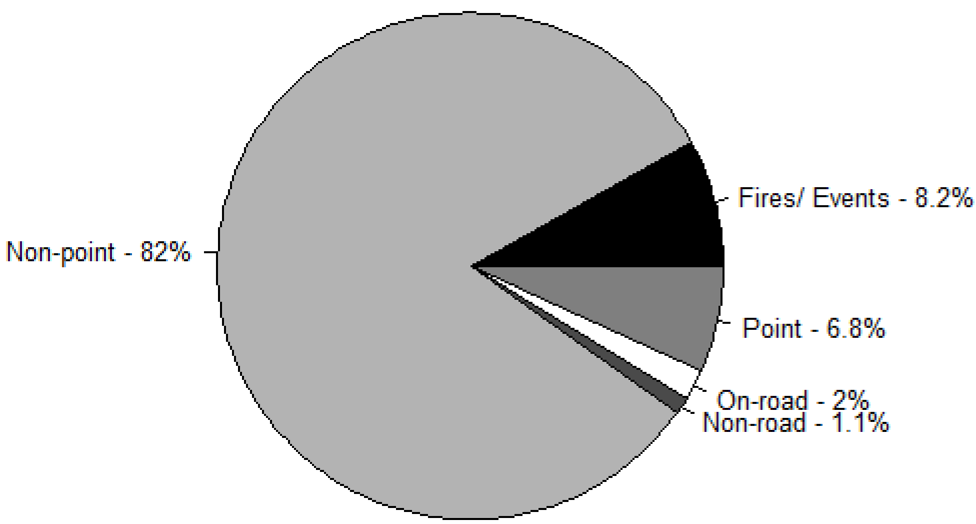
The total NO_x emissions were 324,707 tons per year. Mobile sources made up almost 50 percent of statewide NO_x emissions. There are 325,722 tons per year of PM_{10} emissions, of which area sources make up in excess of 85 percent of the total emissions. The total amount of $PM_{2.5}$ emissions in South Carolina is 91,286 tons per year. Area sources account for almost 70 percent of the total emissions. There are 243,465 total SO_2 emissions in South Carolina with point sources accounting for over 89 percent of total emissions. There are approximately 1,333,964 tons per year of VOCs emissions in South Carolina. By far, biogenic sources make up the majority of VOCs. In fact, biogenic sources make up over 70 percent of the total amount of VOCs in South Carolina. In 2002, there was a total of 926,739 tons per year of CO emissions reported in the South Carolina. Area and non-road sources combined to account for more than 80 percent of the total CO emissions. The total Lead emissions across South Carolina were 14.08 tons per year. Area sources account for more than 50 percent of statewide lead emissions.

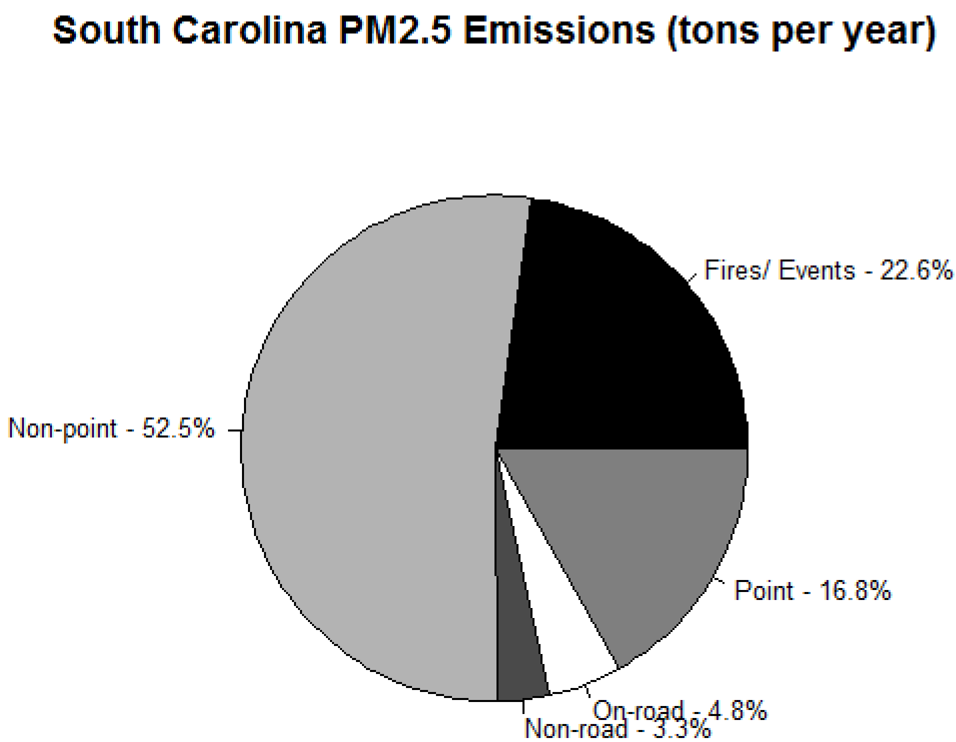
All of the following Emissions pie charts are taken from the 2011 National Emissions Inventory.

South Carolina NOx Emissions (tons per year)

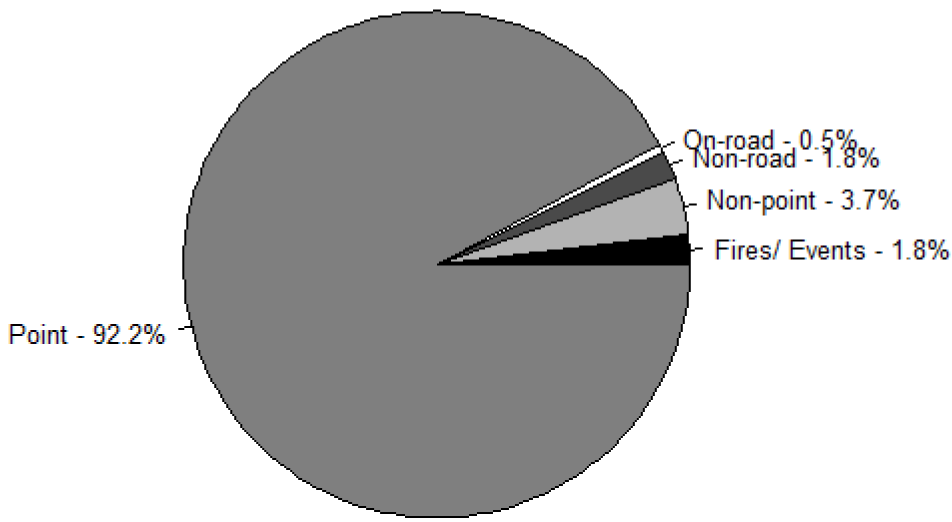


South Carolina PM10 Emissions (tons per year)

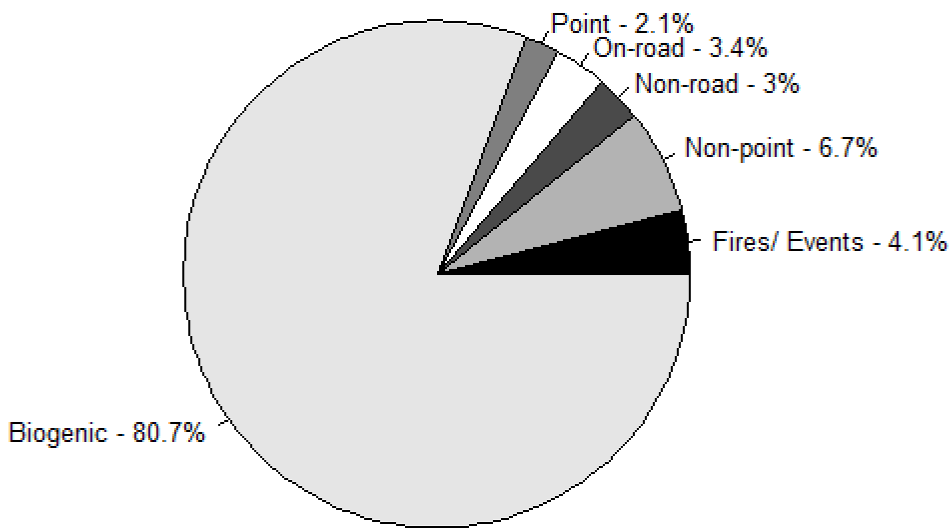


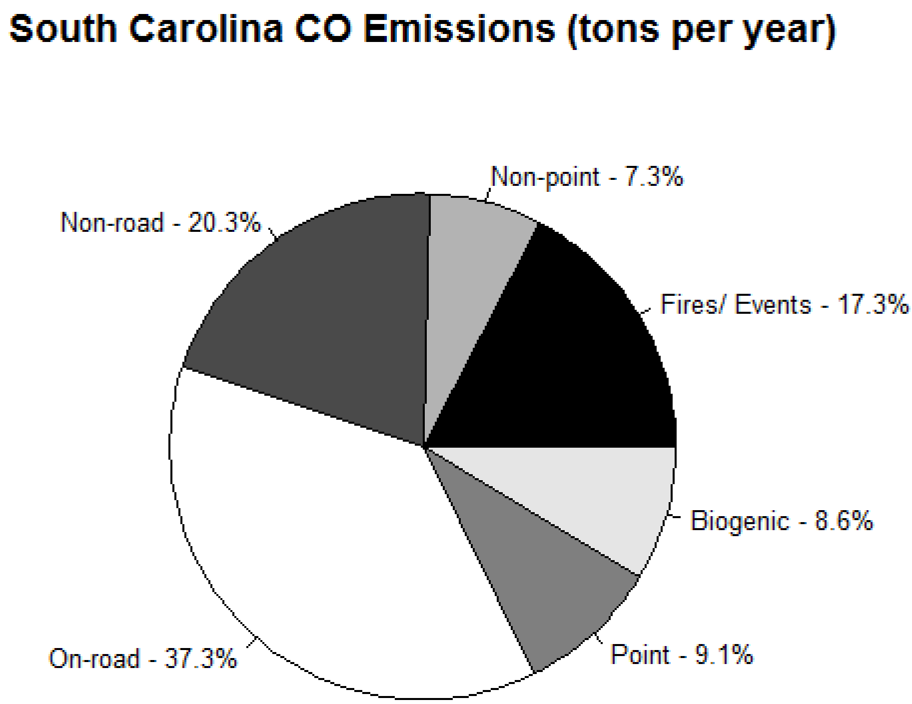

South Carolina PM2.5 Emissions (tons per year)
Fires/ Events - 22.6%
Non-point - 52.5%
Point - 16.8%
On-road - 4.8%
Non-road - 3.3%

South Carolina SO2 Emissions (tons per year)



South Carolina VOC Emissions (tons per year)

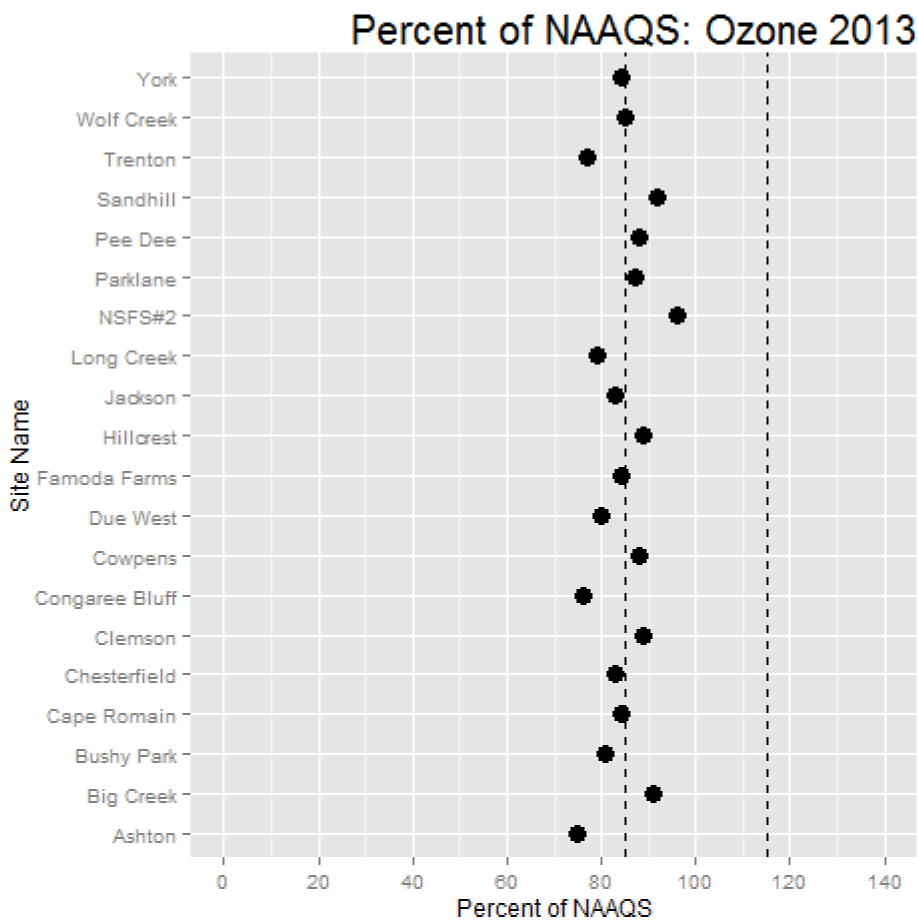



South Carolina CO Emissions (tons per year)
Non-point - 7.3%
Non-road - 20.3%
Fires/ Events - 17.3%
Biogenic - 8.6%
On-road - 37.3%
Point - 9.1%

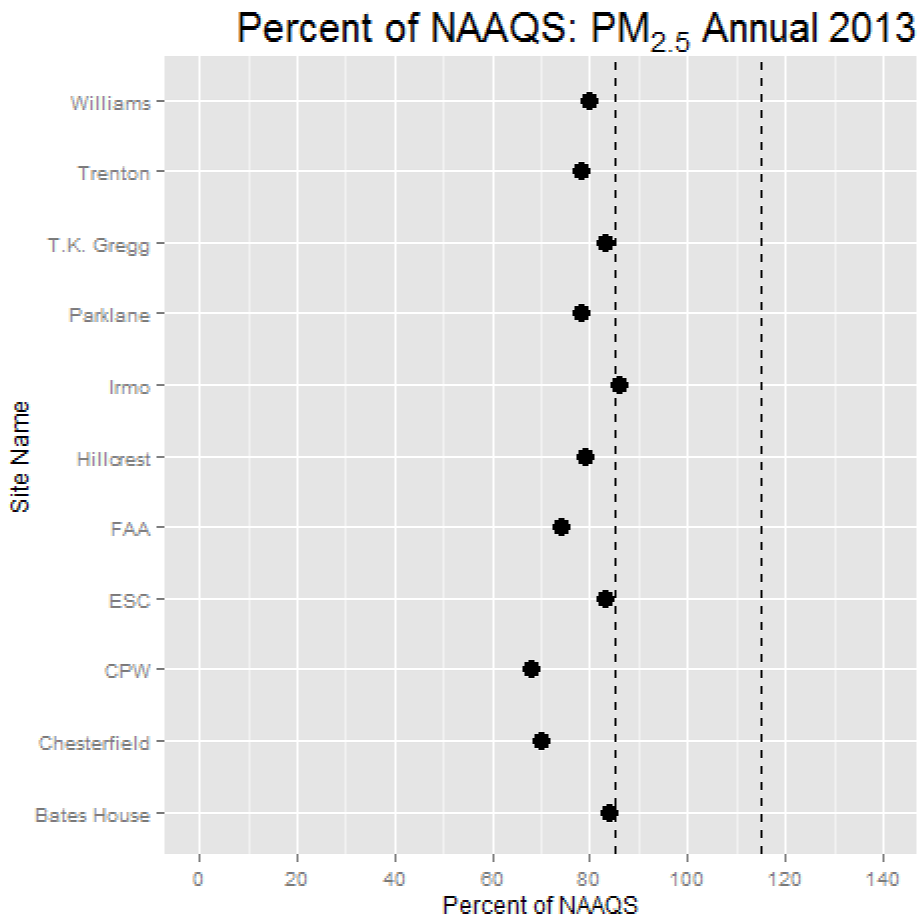
Appendix F: Current air quality and ambient air data trends

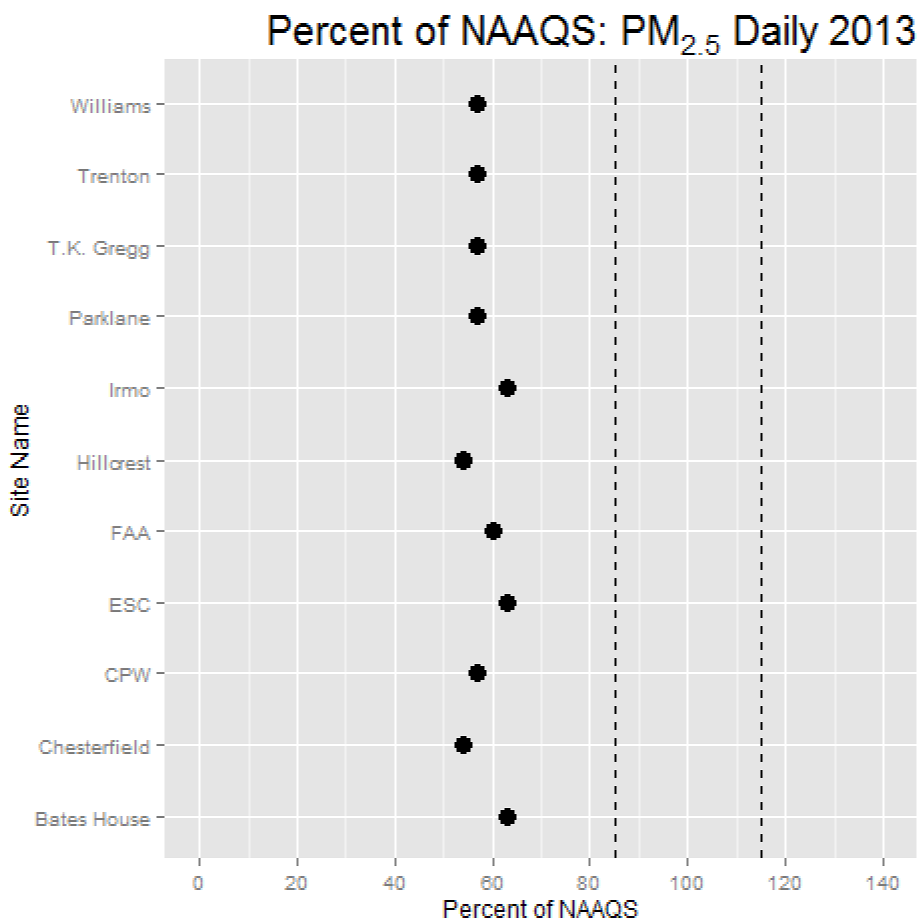
South Carolina currently attains all of the seven National Ambient Air Quality Standards. The graphs below depict the 2013 design values as the percentage of the standard for each criteria pollutant. The dashed vertical lines on each graph depict ±15 percent of the standard. For the purposes of this assessment, a monitor that had a design value ±15 percent of the standard was deemed to be of high importance in providing information concerning NAAQS compliance.

Ozone concentrations in 2013 hovered near 75 - 95 percent of the Ozone NAAQS (set at 0.075 ppm as of this writing). All of the ozone monitoring sites in South Carolina have design values below the level of the standard.



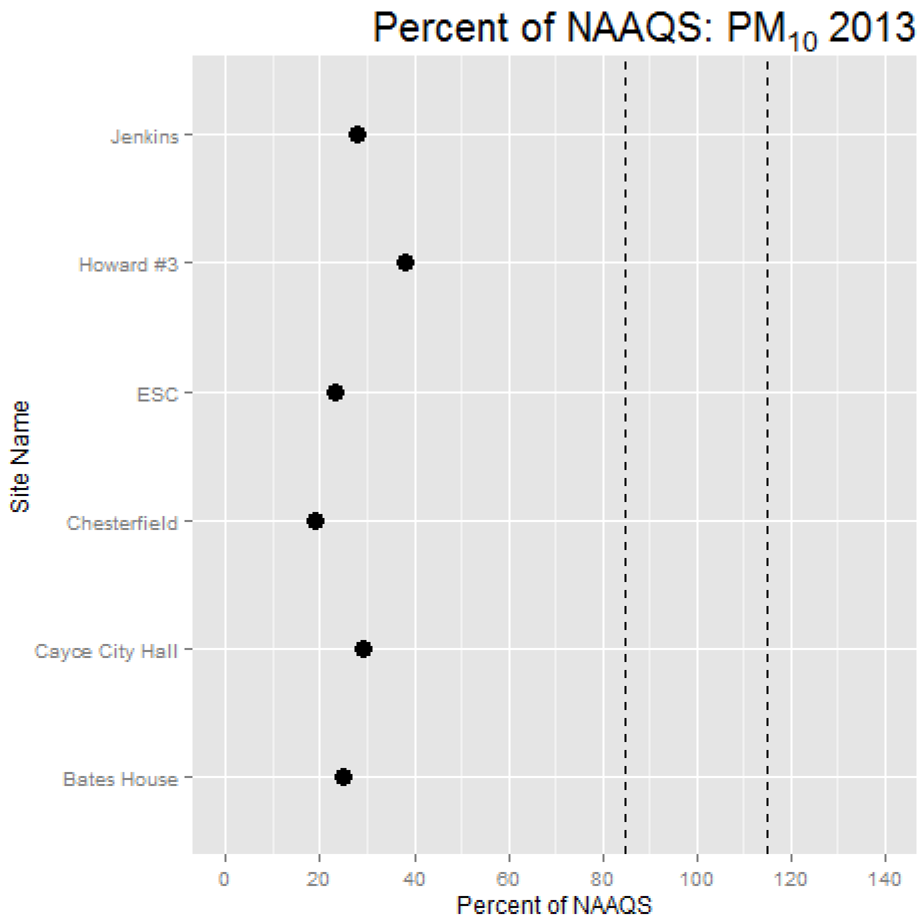
$PM_{2.5}$ concentrations across the state, for the most part, are less than 85 percent of the NAAQS, with a few exceptions. The sites that are greater than 85 percent of the NAAQS are located in urbanized areas where $PM_{2.5}$ emissions tend to be higher.



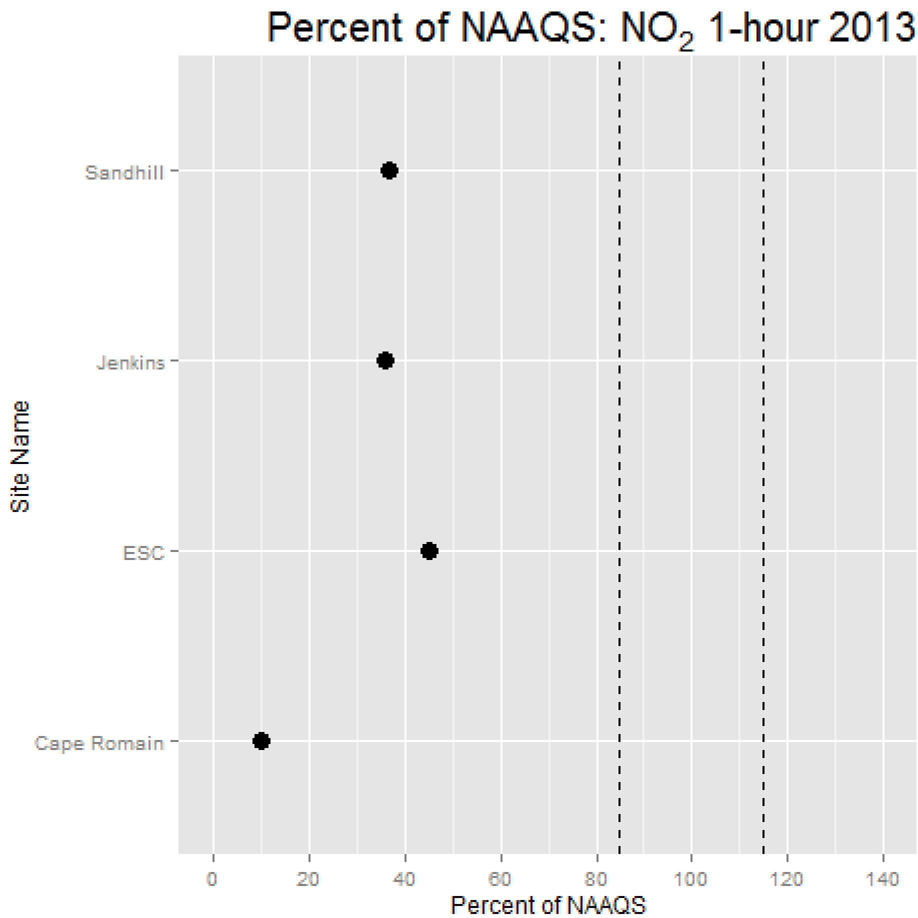


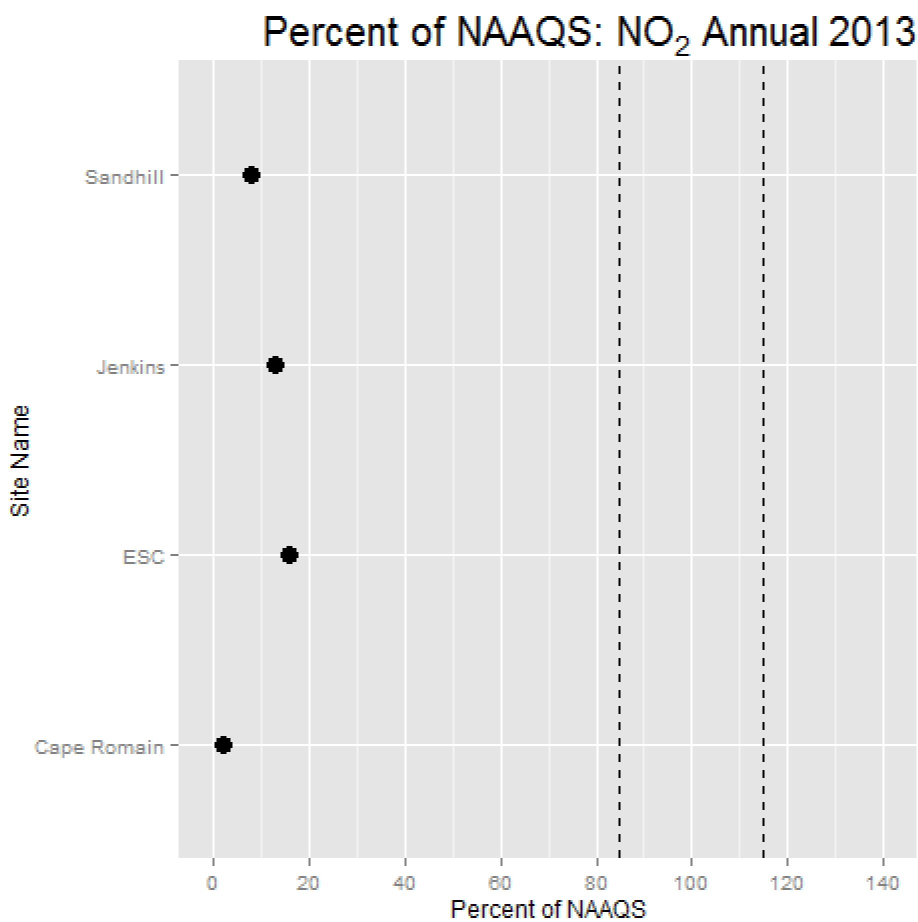
Percent of NAAQS: $PM_{2.5}$ Daily 2013
Site Name
Williams
Trenton
T.K. Gregg
Parklane
Irmo
Hillcrest
FAA
ESC
CPW
Chesterfield
Bates House
0
20
40
60
80
100
120
140
Percent of NAAQS

All monitoring for PM_{10} is well below the level of the NAAQS.

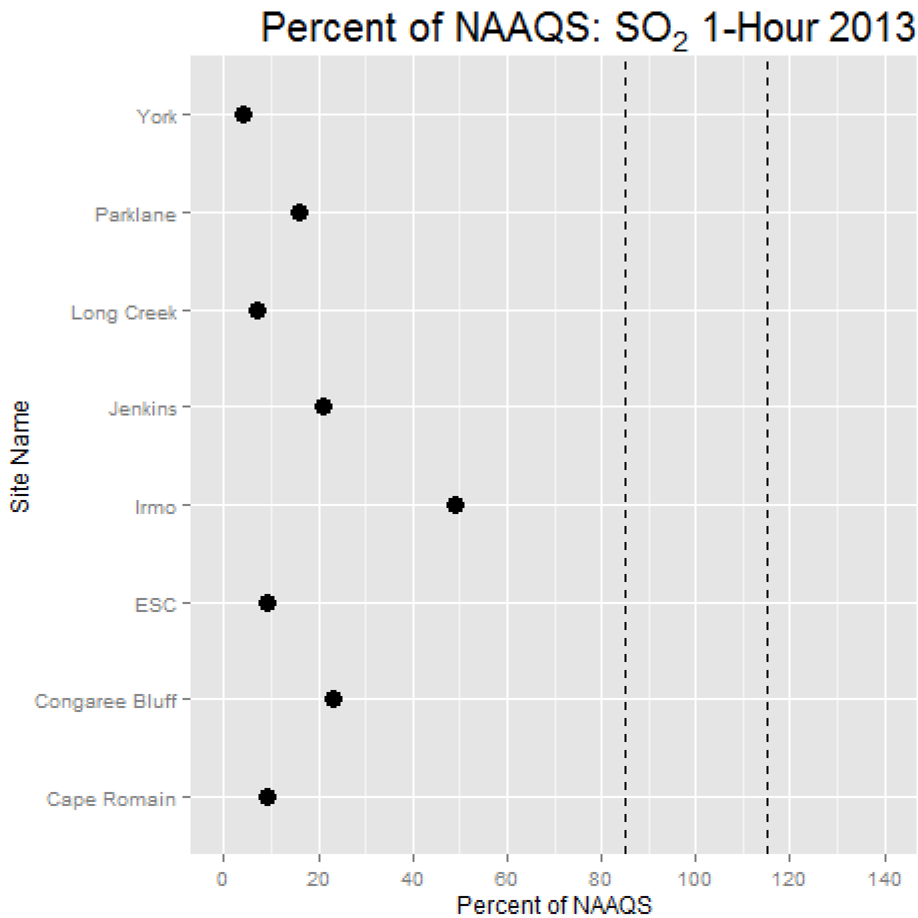


All monitoring for NO_2 is well below the level of the NAAQS.

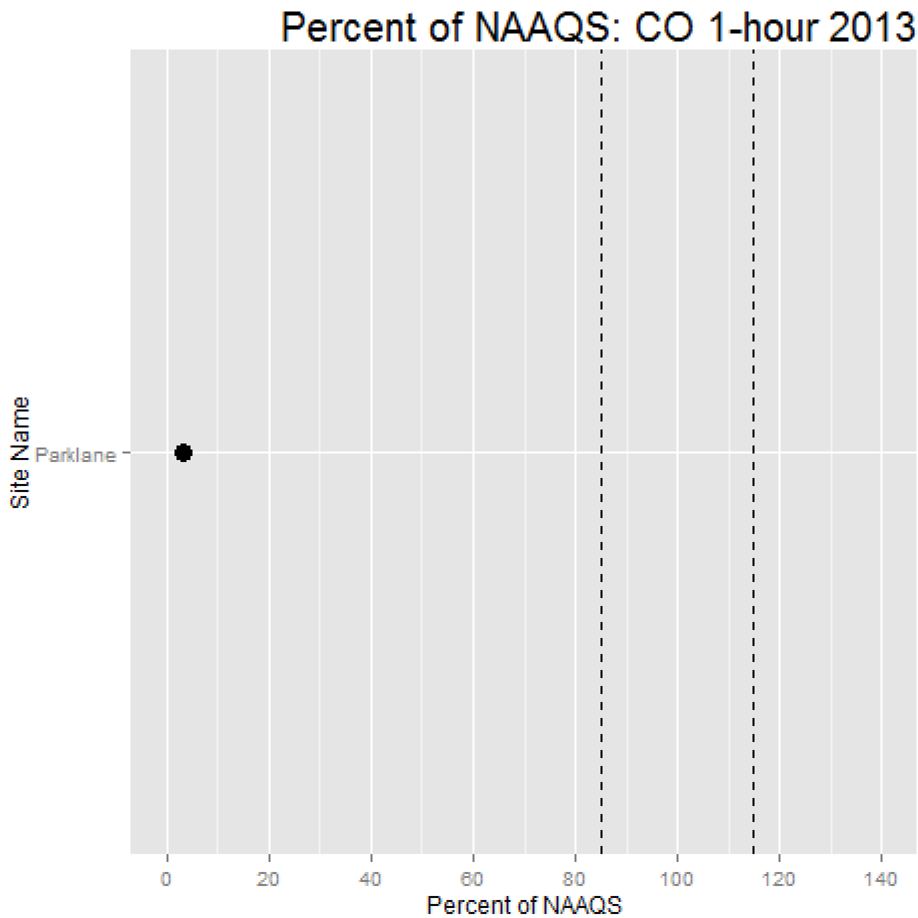


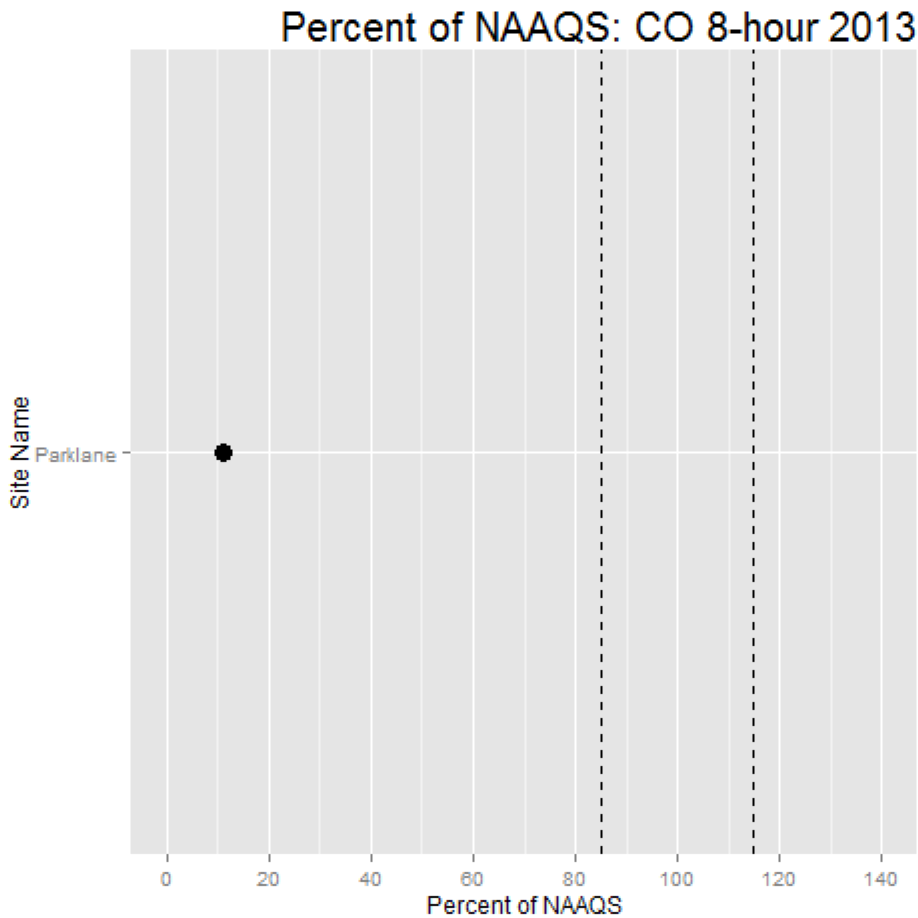

Percent of NAAQS: NO_2 Annual 2013
Site Name
Sandhill
Jenkins
ESC
Cape Romain
0
20
40
60
80
100
120
140
Percent of NAAQS

All monitoring for SO_2 is well below the level of the NAAQS.



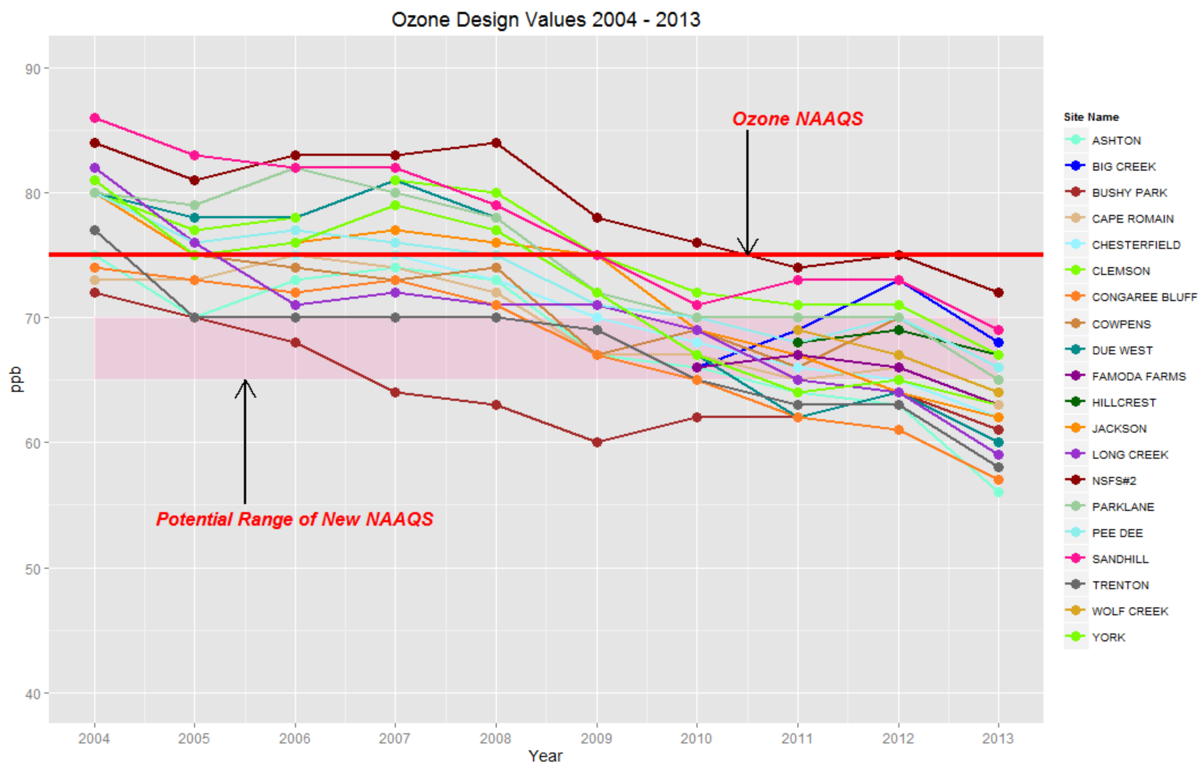
All monitoring for CO is well below the level of the NAAQS.

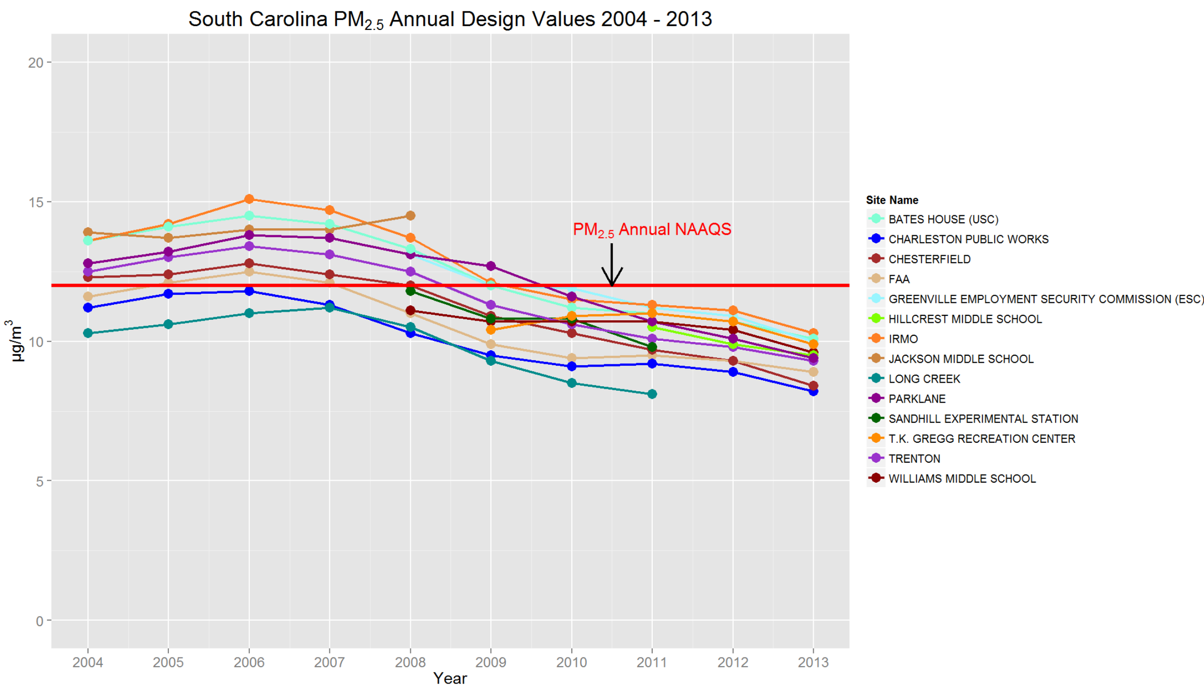


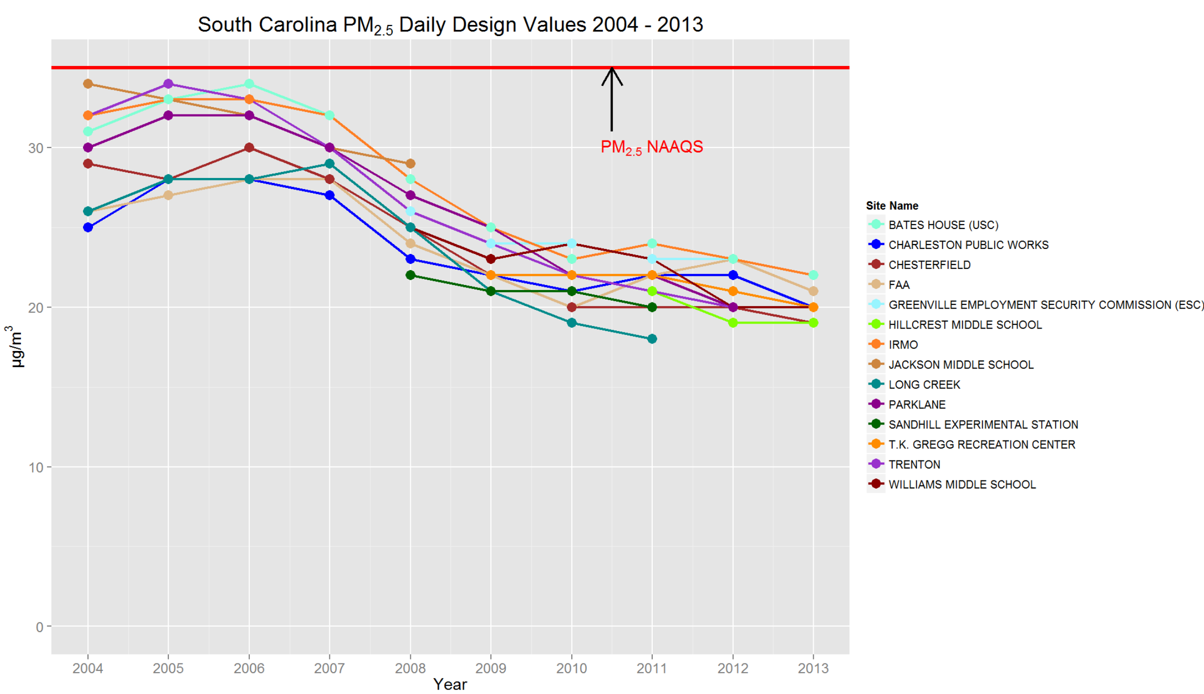


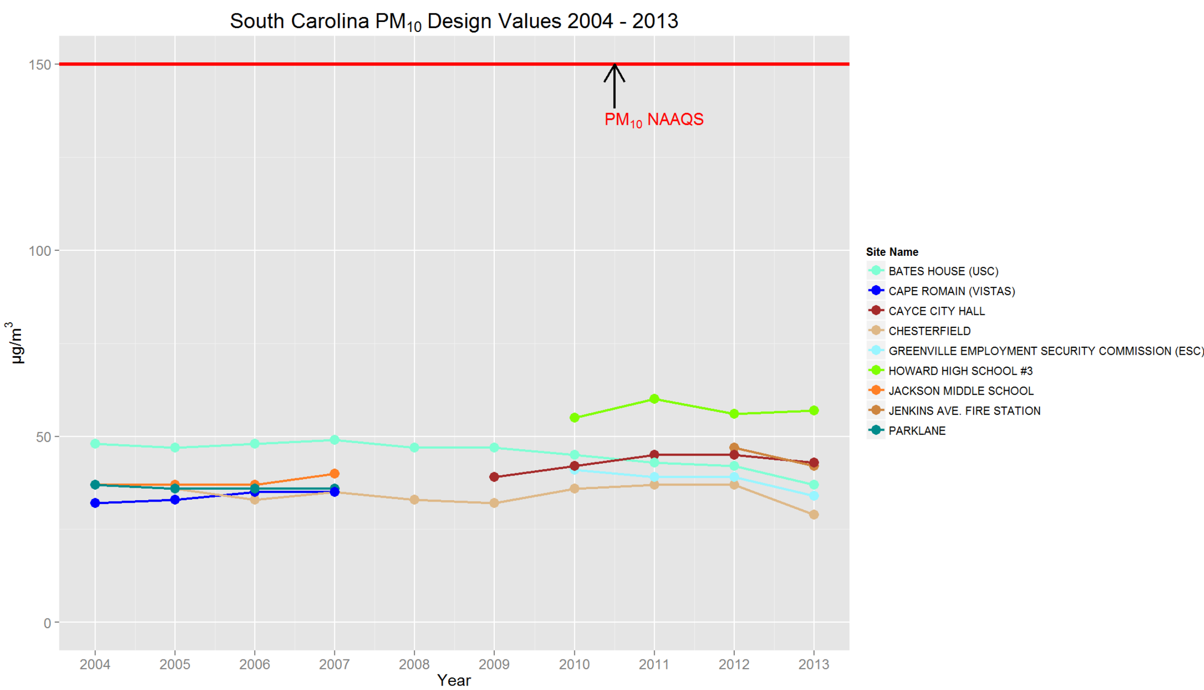
Percent of NAAQS: CO 8-hour 2013
Site Name
Parklane
0
20
40
60
80
100
120
140
Percent of NAAQS

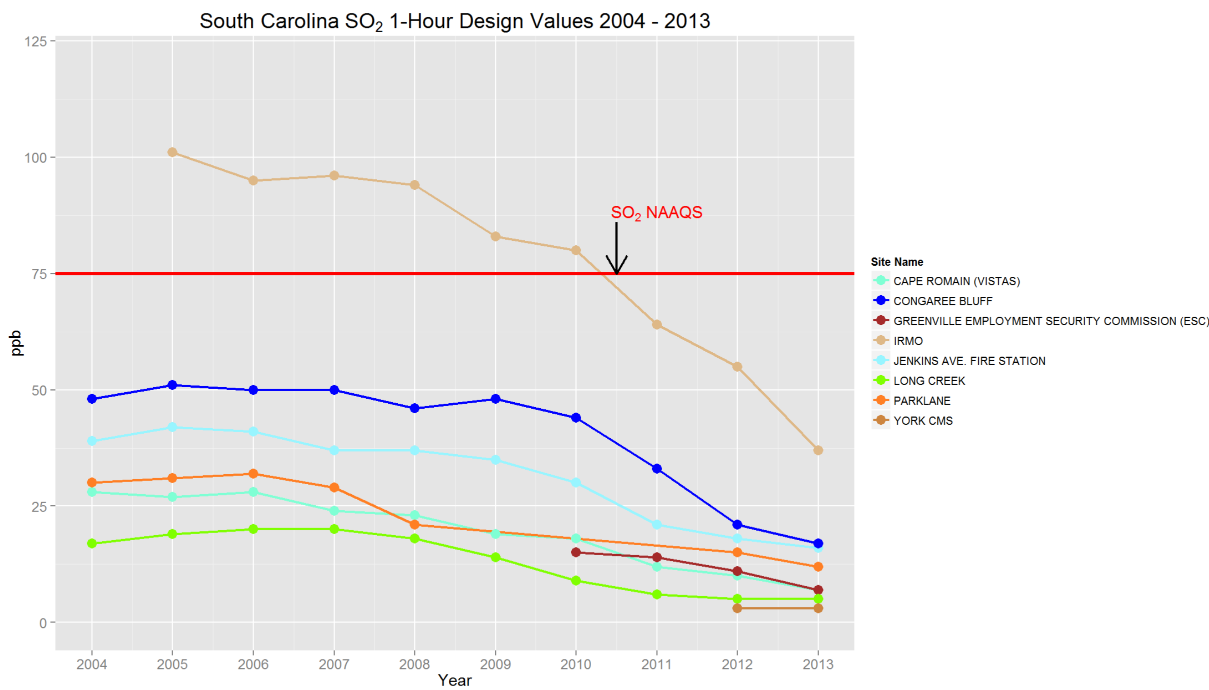
The following graphs provide trends in the design values for each of the pollutants for data collected from 2004 to 2013. These graphs demonstrate that South Carolina is currently measuring ambient concentrations below the level of the NAAQS for all criteria pollutants.



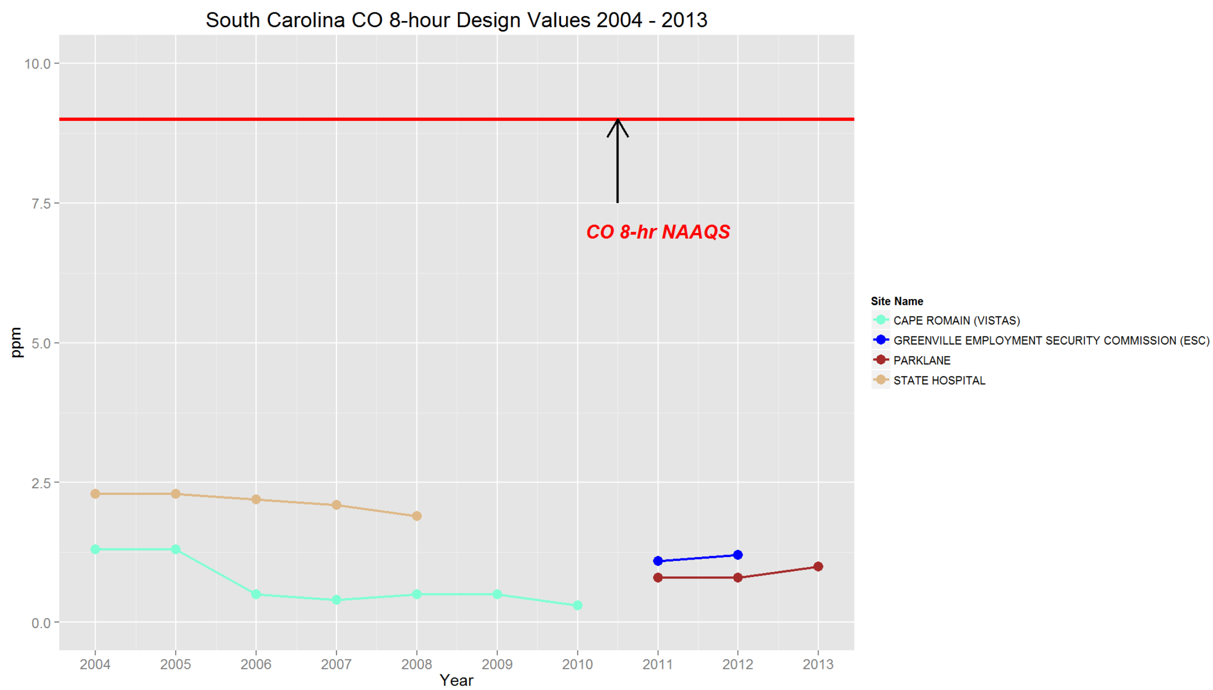

South Carolina PM2.5 Annual Design Values 2004 - 2013
PM2.5 Annual NAAQS
µg/m3
Year
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
0
5
10
15
20
Site Name
BATES HOUSE (USC)
CHARLESTON PUBLIC WORKS
CHESTERFIELD
FAA
GREENVILLE EMPLOYMENT SECURITY COMMISSION (ESC)
HILLCREST MIDDLE SCHOOL
IRMO
JACKSON MIDDLE SCHOOL
LONG CREEK
PARKLANE
SANDHILL EXPERIMENTAL STATION
T.K. GREGG RECREATION CENTER
TRENTON
WILLIAMS MIDDLE SCHOOL

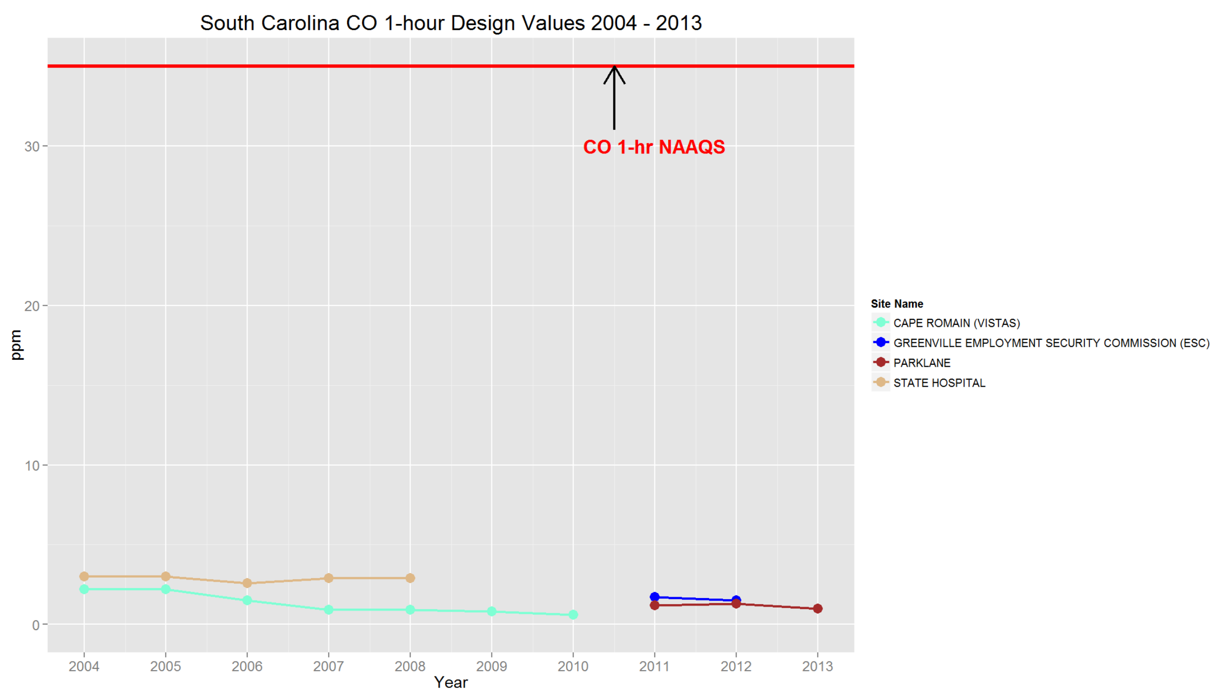

South Carolina PM2.5 Daily Design Values 2004 - 2013
PM2.5 NAAQS
µg/m3
Year
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
0
10
20
30
Site Name
BATES HOUSE (USC)
CHARLESTON PUBLIC WORKS
CHESTERFIELD
FAA
GREENVILLE EMPLOYMENT SECURITY COMMISSION (ESC)
HILLCREST MIDDLE SCHOOL
IRMO
JACKSON MIDDLE SCHOOL
LONG CREEK
PARKLANE
SANDHILL EXPERIMENTAL STATION
T.K. GREGG RECREATION CENTER
TRENTON
WILLIAMS MIDDLE SCHOOL

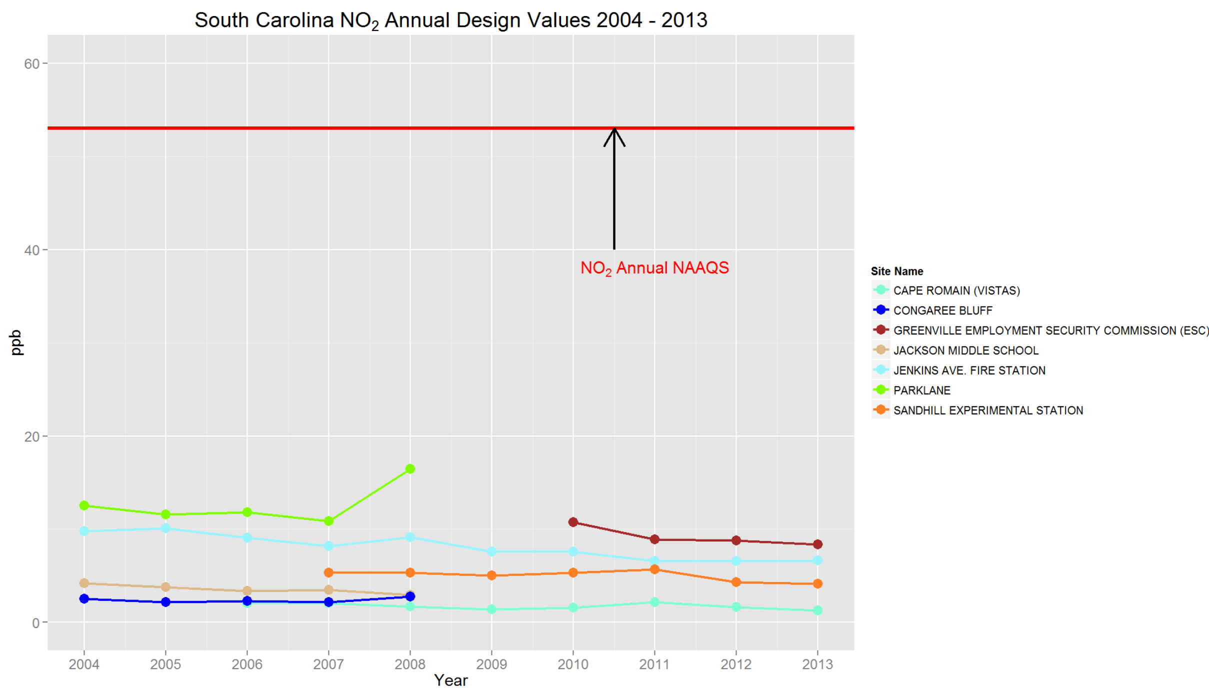

South Carolina PM10 Design Values 2004 - 2013
150
100
50
0
µg/m3
PM10 NAAQS
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
Year
Site Name
BATES HOUSE (USC)
CAPE ROMAIN (VISTAS)
CAYCE CITY HALL
CHESTERFIELD
GREENVILLE EMPLOYMENT SECURITY COMMISSION (ESC)
HOWARD HIGH SCHOOL #3
JACKSON MIDDLE SCHOOL
JENKINS AVE. FIRE STATION
PARKLANE



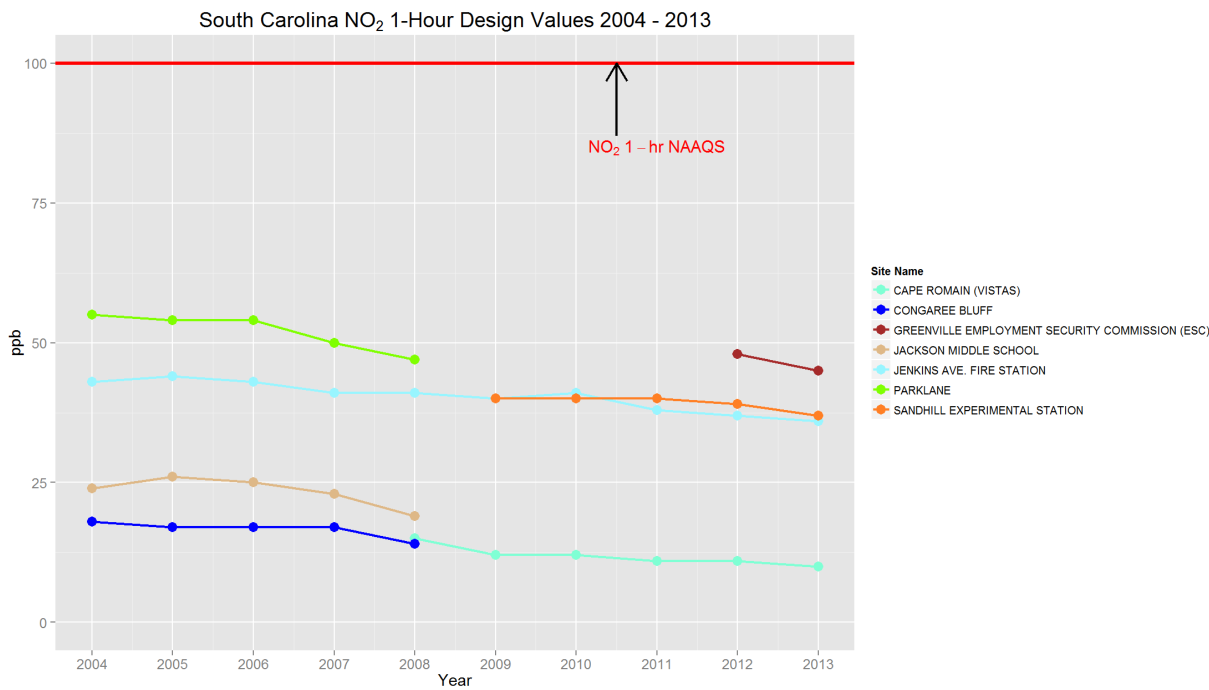
South Carolina SO_2 1-Hour Design Values 2004 - 2013
SO_2 NAAQS
ppb
Year
Site Name
CAPE ROMAIN (VISTAS)
CONGAREE BLUFF
GREENVILLE EMPLOYMENT SECURITY COMMISSION (ESC)
IRMO
JENKINS AVE. FIRE STATION
LONG CREEK
PARKLANE
YORK CMS


South Carolina CO 8-hour Design Values 2004 - 2013
10.0
7.5
5.0
2.5
0.0
ppm
CO 8-hr NAAQS
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
Year
Site Name
CAPE ROMAIN (VISTAS)
GREENVILLE EMPLOYMENT SECURITY COMMISSION (ESC)
PARKLANE
STATE HOSPITAL


South Carolina CO 1-hour Design Values 2004 - 2013
30
20
10
0
ppm
CO 1-hr NAAQS
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
Year
Site Name
CAPE ROMAIN (VISTAS)
GREENVILLE EMPLOYMENT SECURITY COMMISSION (ESC)
PARKLANE
STATE HOSPITAL



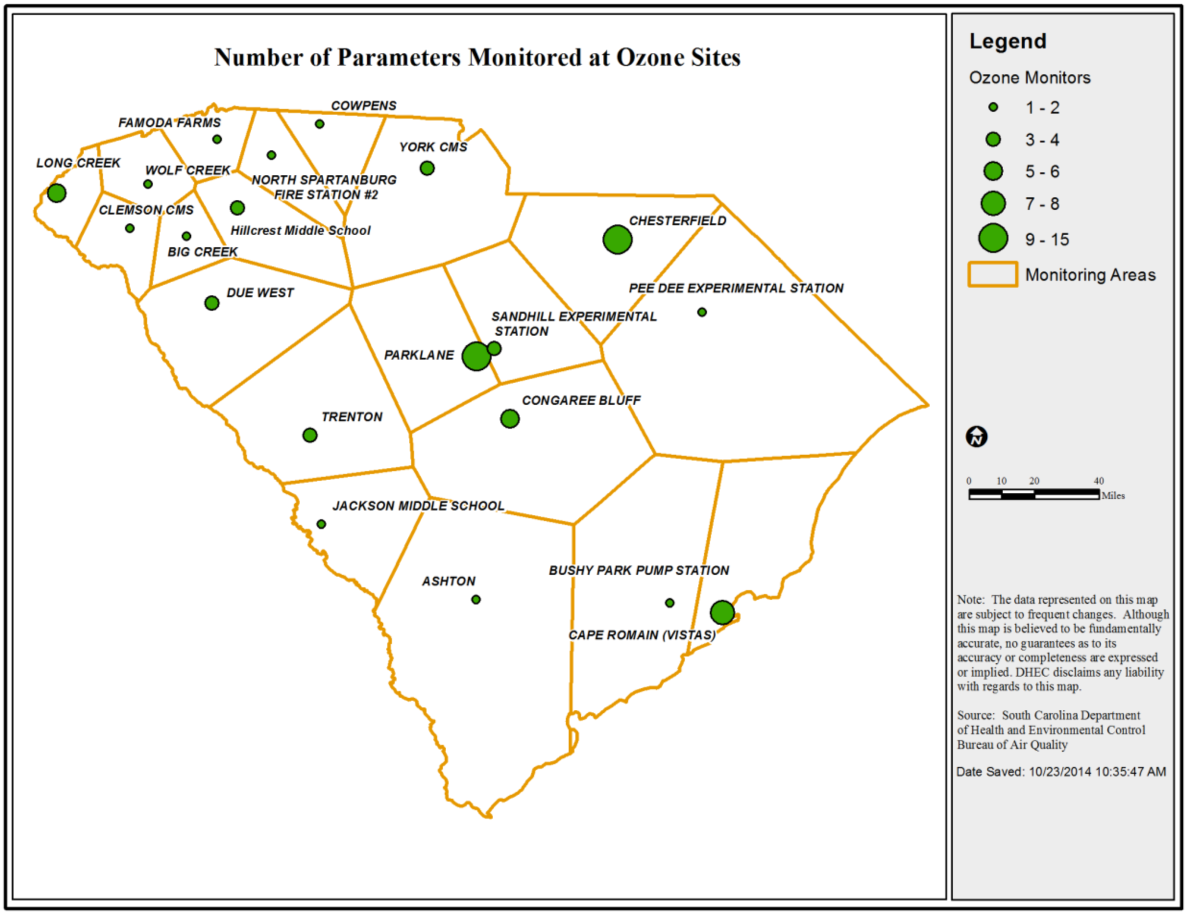
South Carolina NO_2 Annual Design Values 2004 - 2013
ppb
60
40
20
0
NO_2 Annual NAAQS
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
Year
Site Name
CAPE ROMAIN (VISTAS)
CONGAREE BLUFF
GREENVILLE EMPLOYMENT SECURITY COMMISSION (ESC)
JACKSON MIDDLE SCHOOL
JENKINS AVE. FIRE STATION
PARKLANE
SANDHILL EXPERIMENTAL STATION

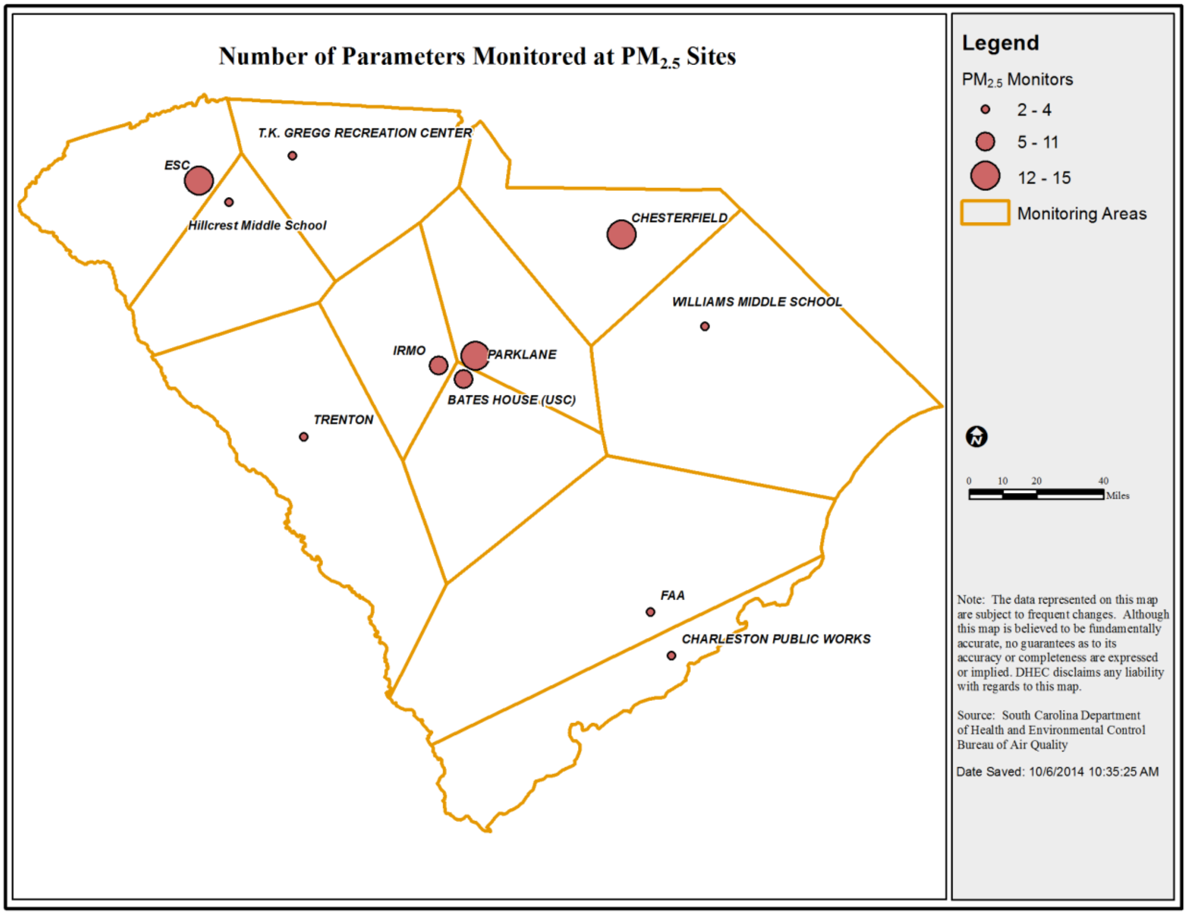


South Carolina NO_2 1-Hour Design Values 2004 - 2013
100
75
50
25
0
ppb
NO_2 1 – hr NAAQS
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
Year
Site Name
CAPE ROMAIN (VISTAS)
CONGAREE BLUFF
GREENVILLE EMPLOYMENT SECURITY COMMISSION (ESC)
JACKSON MIDDLE SCHOOL
JENKINS AVE. FIRE STATION
PARKLANE
SANDHILL EXPERIMENTAL STATION

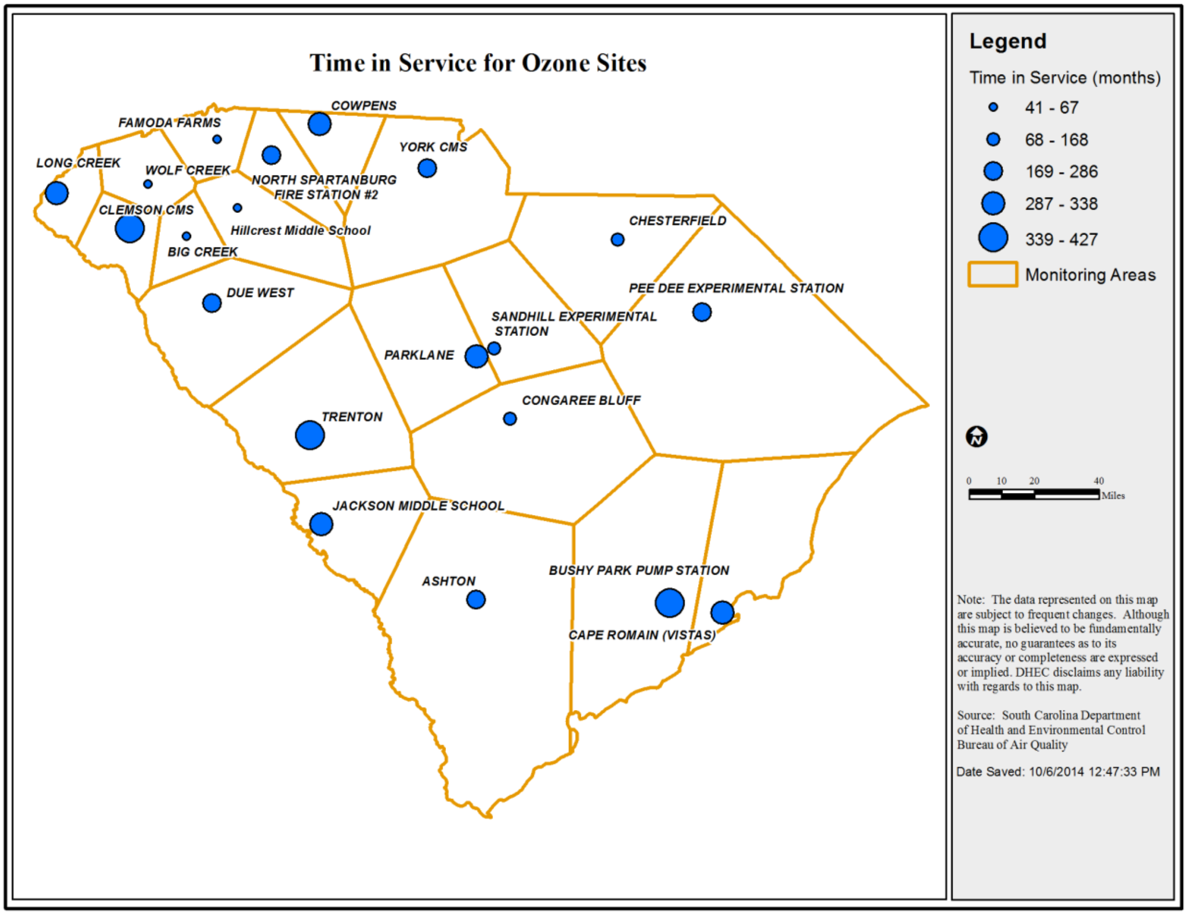
Appendix G: Maps depicting steps of the technical assessment of the Ozone and $PM_{2.5}$ ambient air monitoring networks

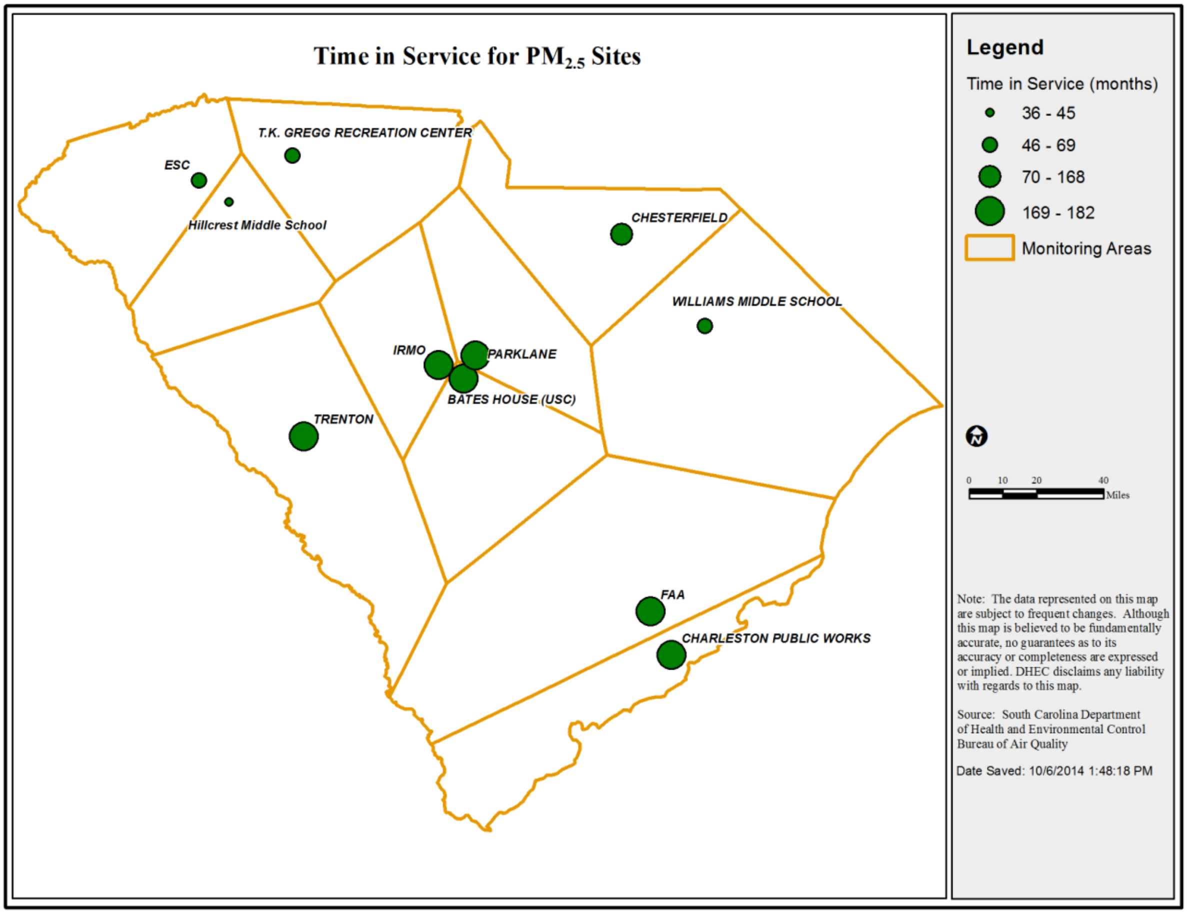
Number of other parameters monitored at the site



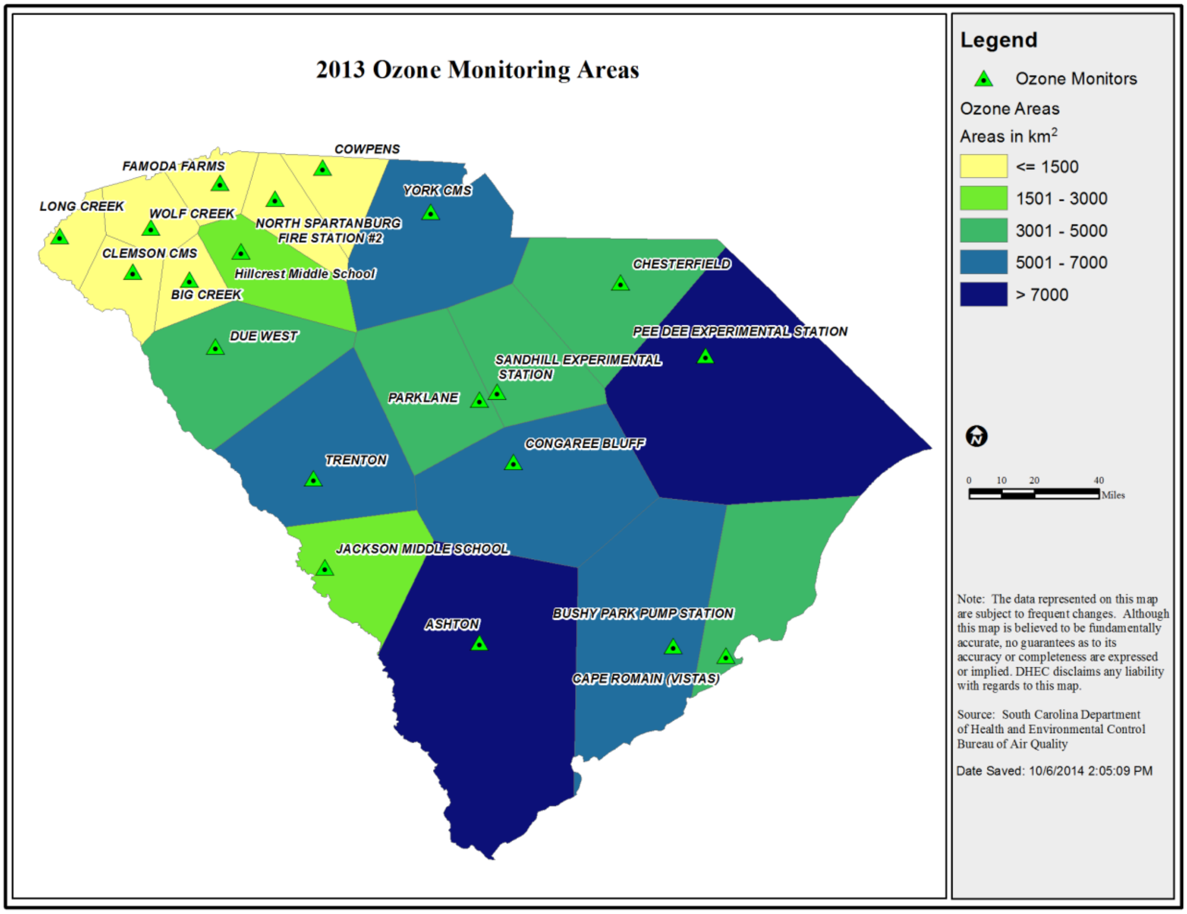

Number of Parameters Monitored at PM2.5 Sites
T.K. GREGG RECREATION CENTER
ESC
Hillcrest Middle School
CHESTERFIELD
WILLIAMS MIDDLE SCHOOL
IRMO
PARKLANE
BATES HOUSE (USC)
TRENTON
FAA
CHARLESTON PUBLIC WORKS
Legend
PM2.5 Monitors
2 - 4
5 - 11
12 - 15
Monitoring Areas
0 10 20 40
Miles
Note: The data represented on this map are subject to frequent changes. Although this map is believed to be fundamentally accurate, no guarantees as to its accuracy or completeness are expressed or implied. DHEC disclaims any liability with regards to this map.
Source: South Carolina Department of Health and Environmental Control Bureau of Air Quality
Date Saved: 10/6/2014 10:35:25 AM

Trends impact

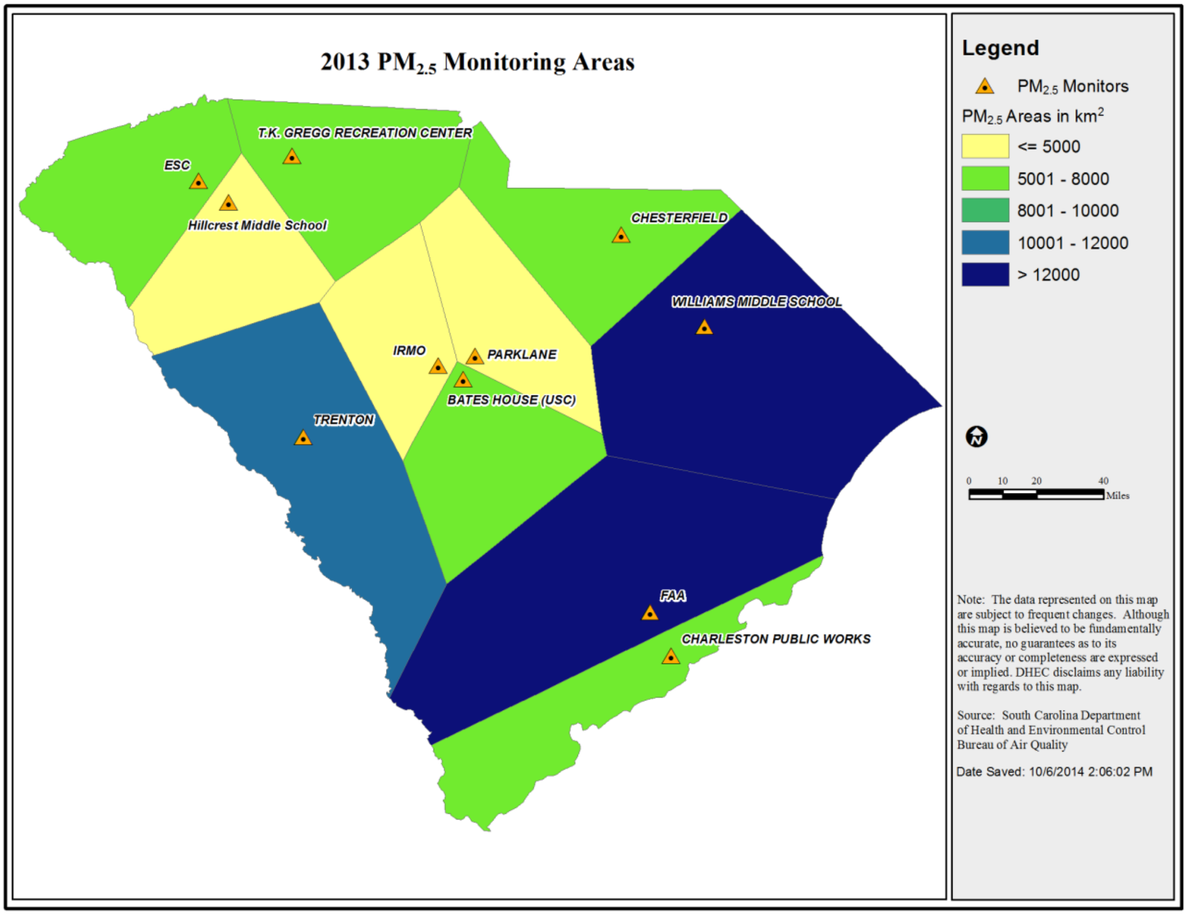



Time in Service for PM2.5 Sites
T.K. GREGG RECREATION CENTER
ESC
Hillcrest Middle School
CHESTERFIELD
WILLIAMS MIDDLE SCHOOL
IRMO
PARKLANE
BATES HOUSE (USC)
TRENTON
FAA
CHARLESTON PUBLIC WORKS
Legend
Time in Service (months)
36 - 45
46 - 69
70 - 168
169 - 182
Monitoring Areas
0 10 20 40
Miles
Note: The data represented on this map are subject to frequent changes. Although this map is believed to be fundamentally accurate, no guarantees as to its accuracy or completeness are expressed or implied. DHEC disclaims any liability with regards to this map.
Source: South Carolina Department of Health and Environmental Control Bureau of Air Quality
Date Saved: 10/6/2014 1:48:18 PM

Area served

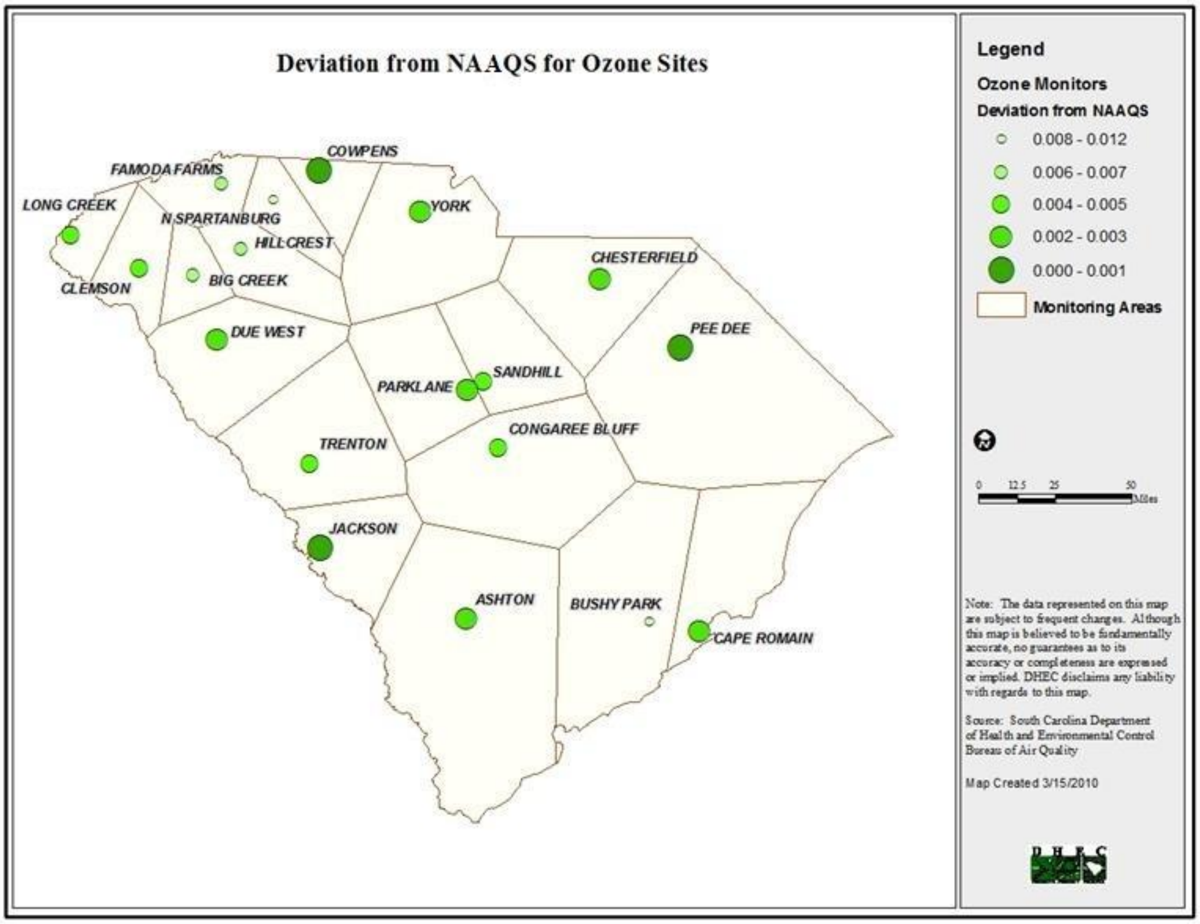


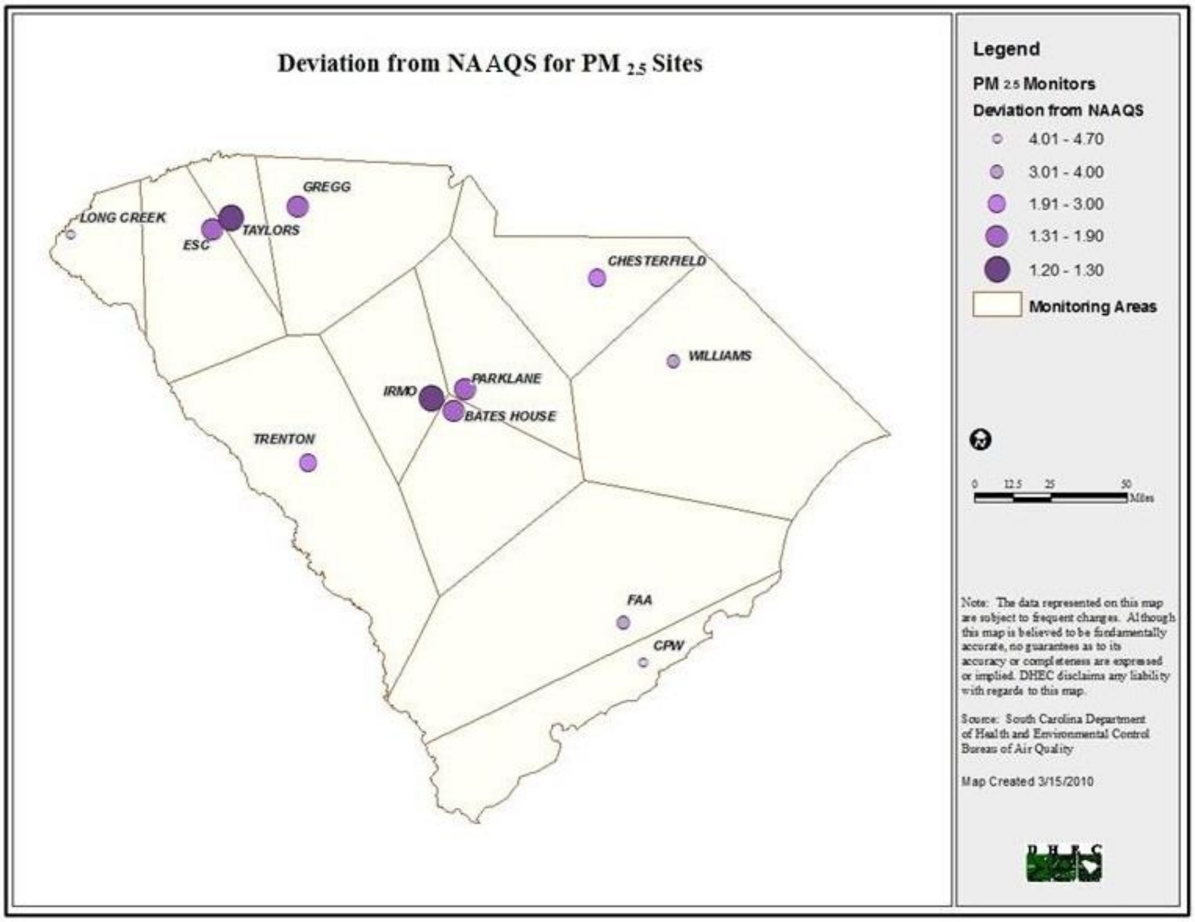
2013 Ozone Monitoring Areas
COWPENS
FAMODA FARMS
LONG CREEK
WOLF CREEK
NORTH SPARTANBURG FIRE STATION #2
YORK CMS
CLEMSON CMS
Hillcrest Middle School
BIG CREEK
CHESTERFIELD
DUE WEST
PEE DEE EXPERIMENTAL STATION
SANDHILL EXPERIMENTAL STATION
PARKLANE
CONGAREE BLUFF
TRENTON
JACKSON MIDDLE SCHOOL
BUSHY PARK PUMP STATION
ASHTON
CAPE ROMAIN (VISTAS)
Legend
Ozone Monitors
Ozone Areas
Areas in km2
<= 1500
1501 - 3000
3001 - 5000
5001 - 7000
> 7000
0 10 20 40 Miles
Note: The data represented on this map are subject to frequent changes. Although this map is believed to be fundamentally accurate, no guarantees as to its accuracy or completeness are expressed or implied. DHEC disclaims any liability with regards to this map.
Source: South Carolina Department of Health and Environmental Control Bureau of Air Quality
Date Saved: 10/6/2014 2:05:09 PM



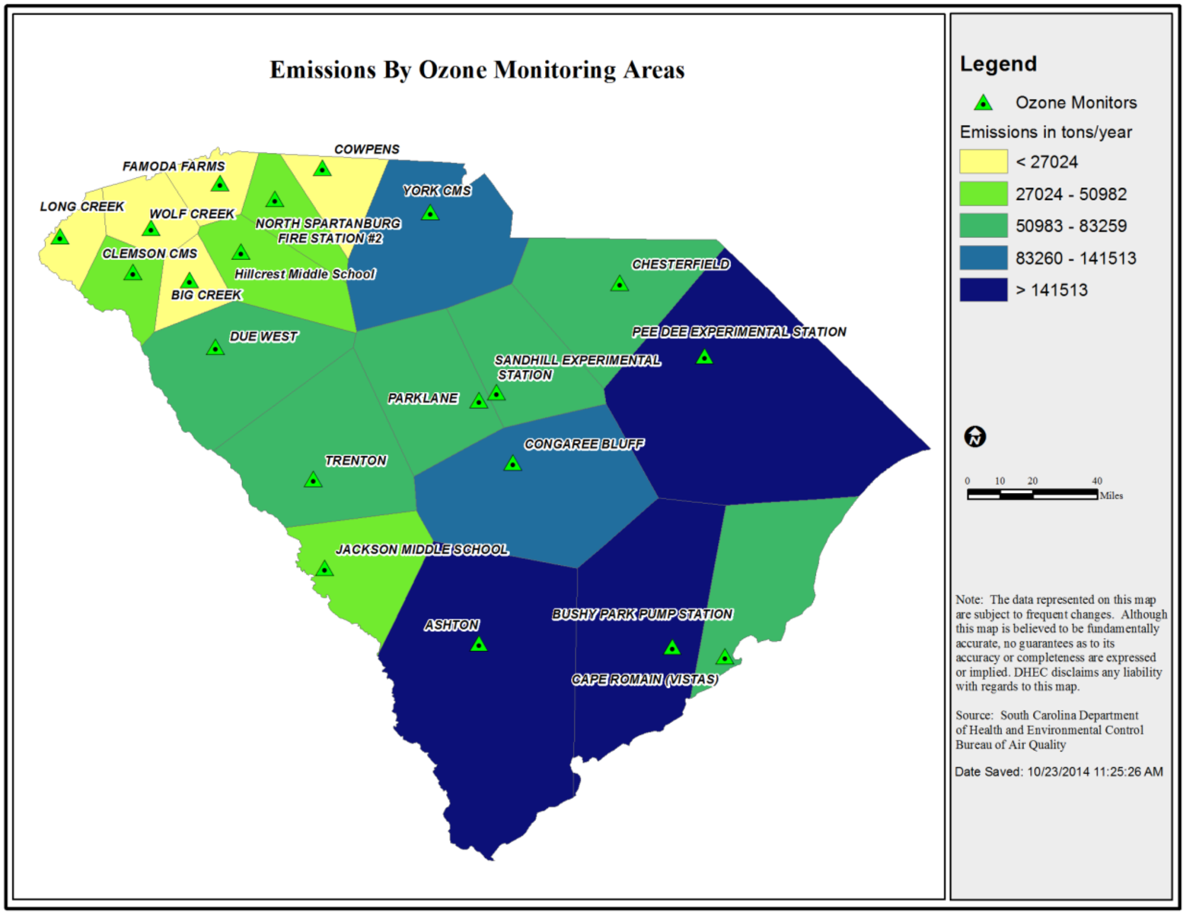
2013 PM2.5 Monitoring Areas
T.K. GREGG RECREATION CENTER
ESC
Hillcrest Middle School
CHESTERFIELD
WILLIAMS MIDDLE SCHOOL
IRMO
PARKLANE
BATES HOUSE (USC)
TRENTON
FAA
CHARLESTON PUBLIC WORKS
Legend
PM2.5 Monitors
PM2.5 Areas in km2
<= 5000
5001 - 8000
8001 - 10000
10001 - 12000
> 12000
0 10 20 40 Miles
Note: The data represented on this map are subject to frequent changes. Although this map is believed to be fundamentally accurate, no guarantees as to its accuracy or completeness are expressed or implied. DHEC disclaims any liability with regards to this map.
Source: South Carolina Department of Health and Environmental Control Bureau of Air Quality
Date Saved: 10/6/2014 2:06:02 PM

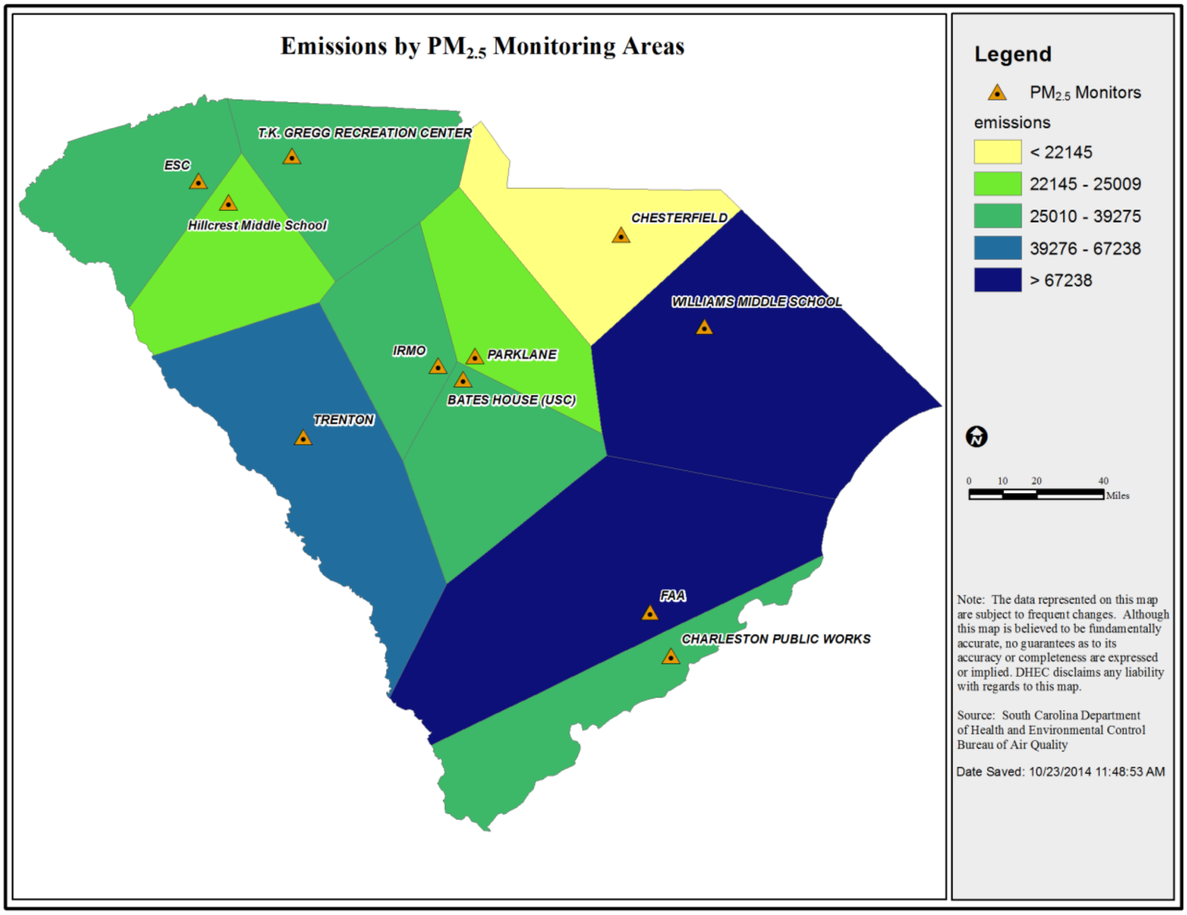
Deviation from NAAQS




Deviation from NAAQS for PM 2.5 Sites
Legend
PM 2.5 Monitors
Deviation from NAAQS
4.01 - 4.70
3.01 - 4.00
1.91 - 3.00
1.31 - 1.90
1.20 - 1.30
Monitoring Areas
LONG CREEK
ESC
TAYLORS
GREGG
CHESTERFIELD
WILLIAMS
IRMO
PARKLANE
BATES HOUSE
TRENTON
FAA
CPW
0 12.5 25 50 Miles
Note: The data represented on this map are subject to frequent changes. Although this map is believed to be fundamentally accurate, no guarantees as to its accuracy or completeness are expressed or implied. DHEC disclaims any liability with regards to this map.
Source: South Carolina Department of Health and Environmental Control Bureau of Air Quality
Map Created 3/15/2010

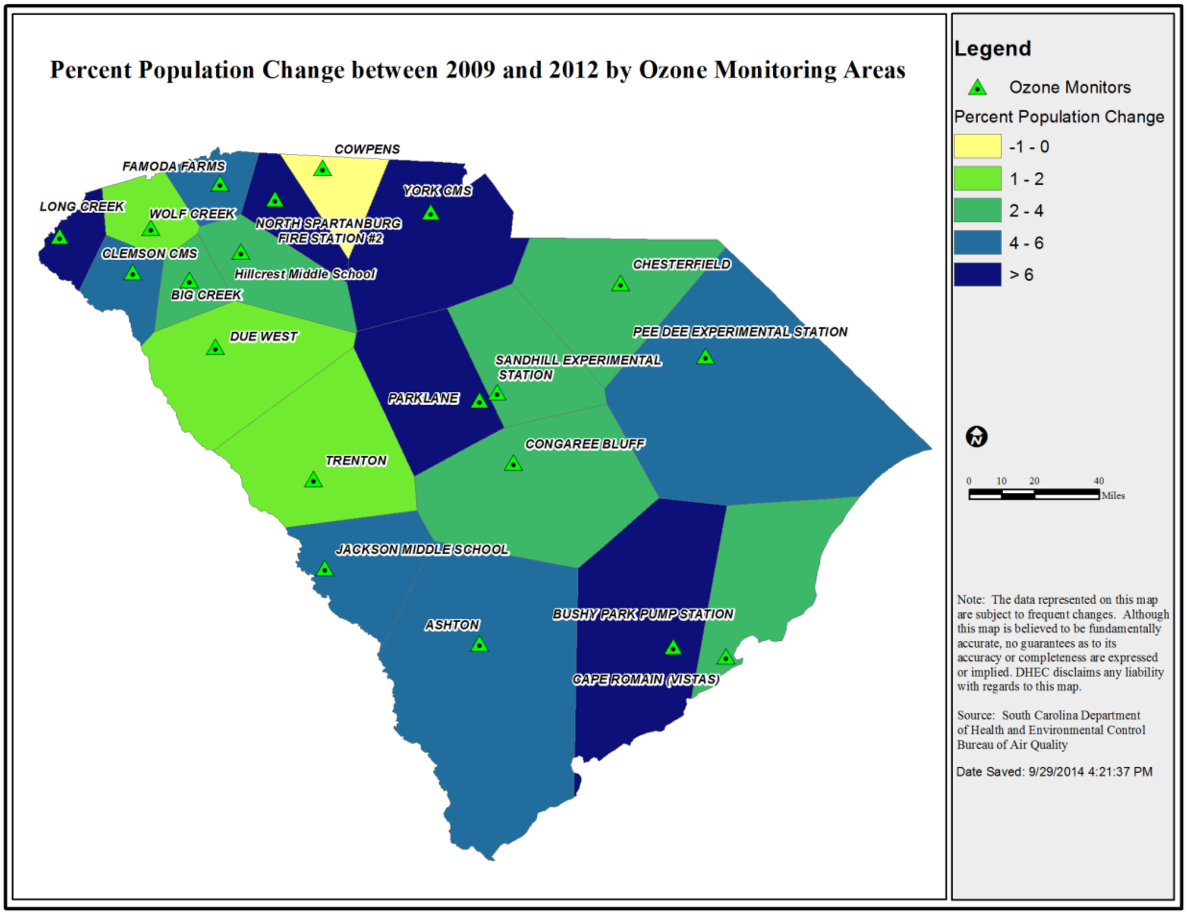
Emission inventory

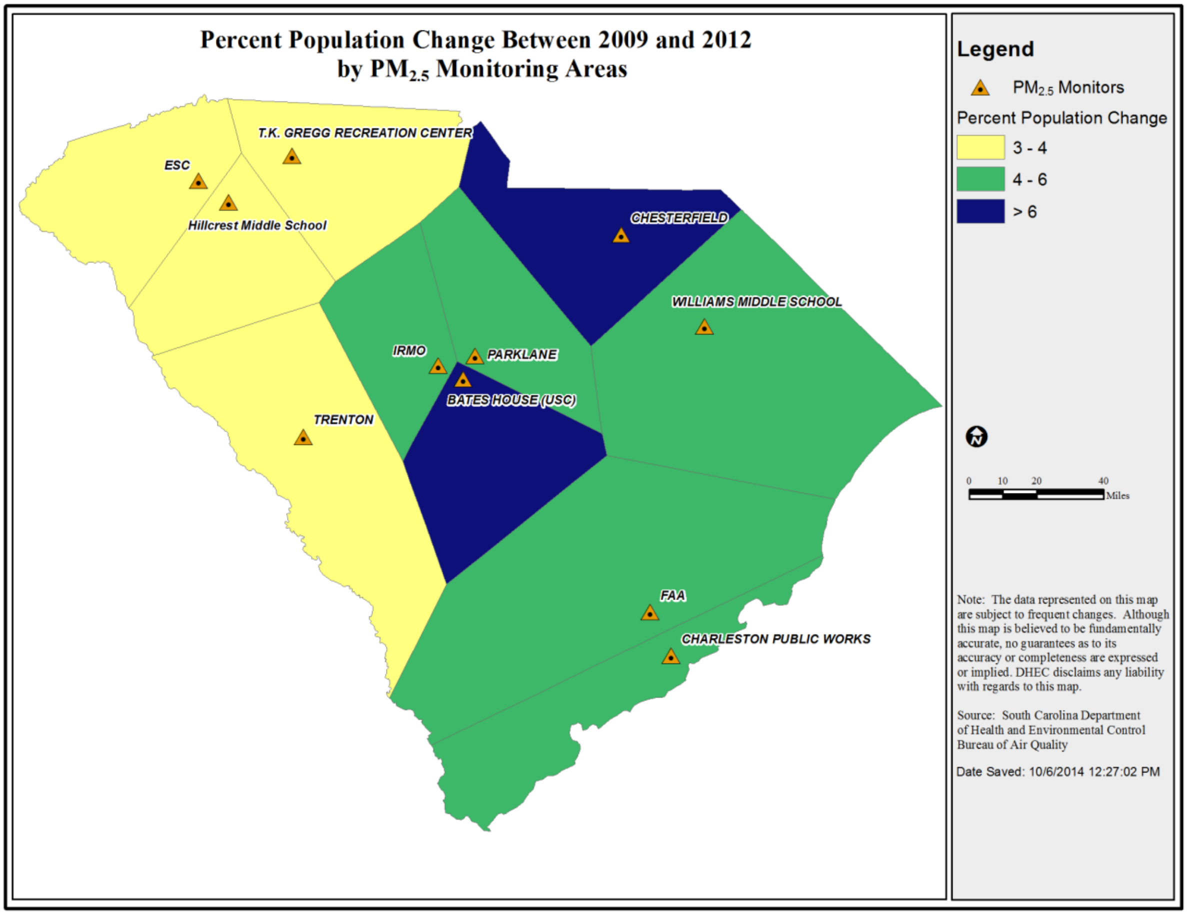




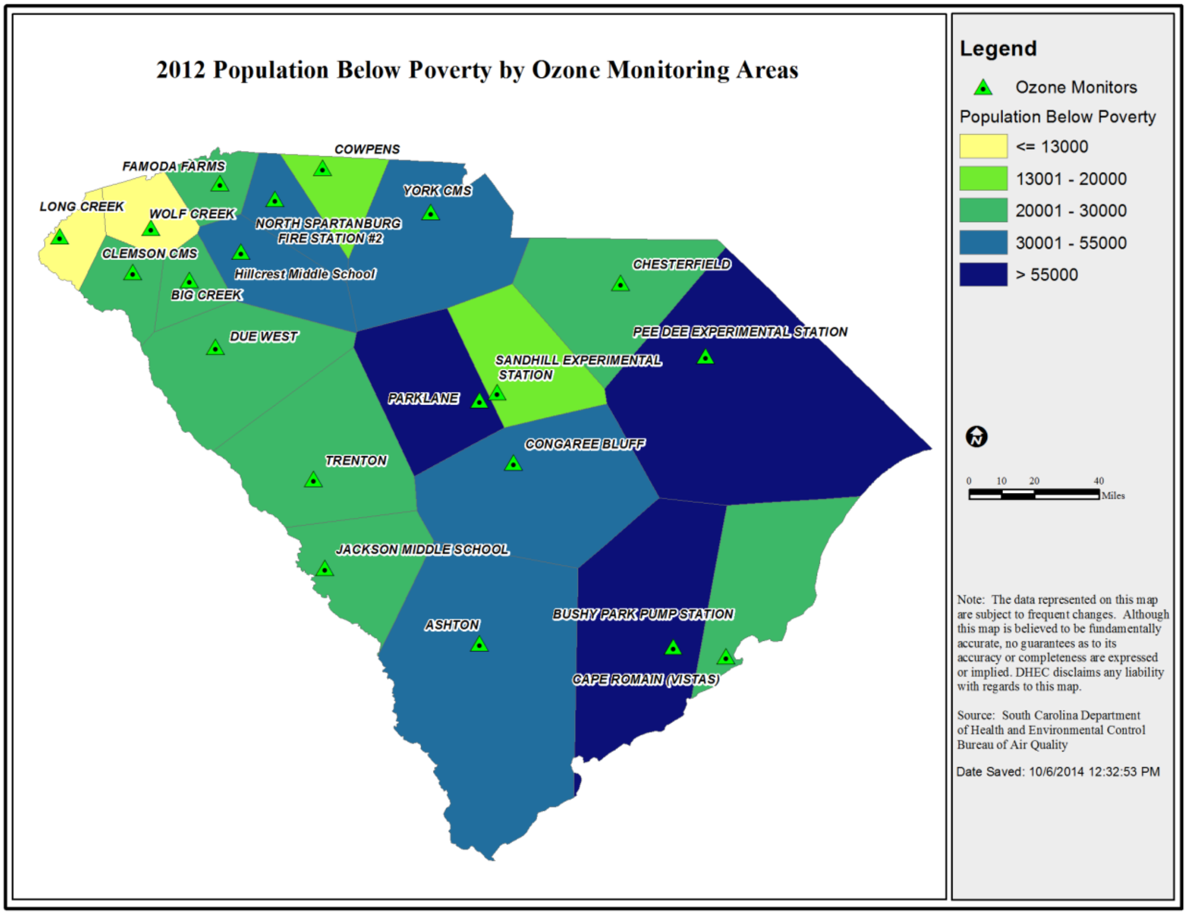
Emissions by $PM_{2.5}$ Monitoring Areas
T.K. GREGG RECREATION CENTER
ESC
Hillcrest Middle School
CHESTERFIELD
WILLIAMS MIDDLE SCHOOL
IRMO
PARKLANE
BATES HOUSE (USC)
TRENTON
FAA
CHARLESTON PUBLIC WORKS
Legend
$PM_{2.5}$ Monitors
emissions
< 22145
22145 - 25009
25010 - 39275
39276 - 67238
> 67238
0 10 20 40 Miles
Note: The data represented on this map are subject to frequent changes. Although this map is believed to be fundamentally accurate, no guarantees as to its accuracy or completeness are expressed or implied. DHEC disclaims any liability with regards to this map.
Source: South Carolina Department of Health and Environmental Control Bureau of Air Quality
Date Saved: 10/23/2014 11:48:53 AM

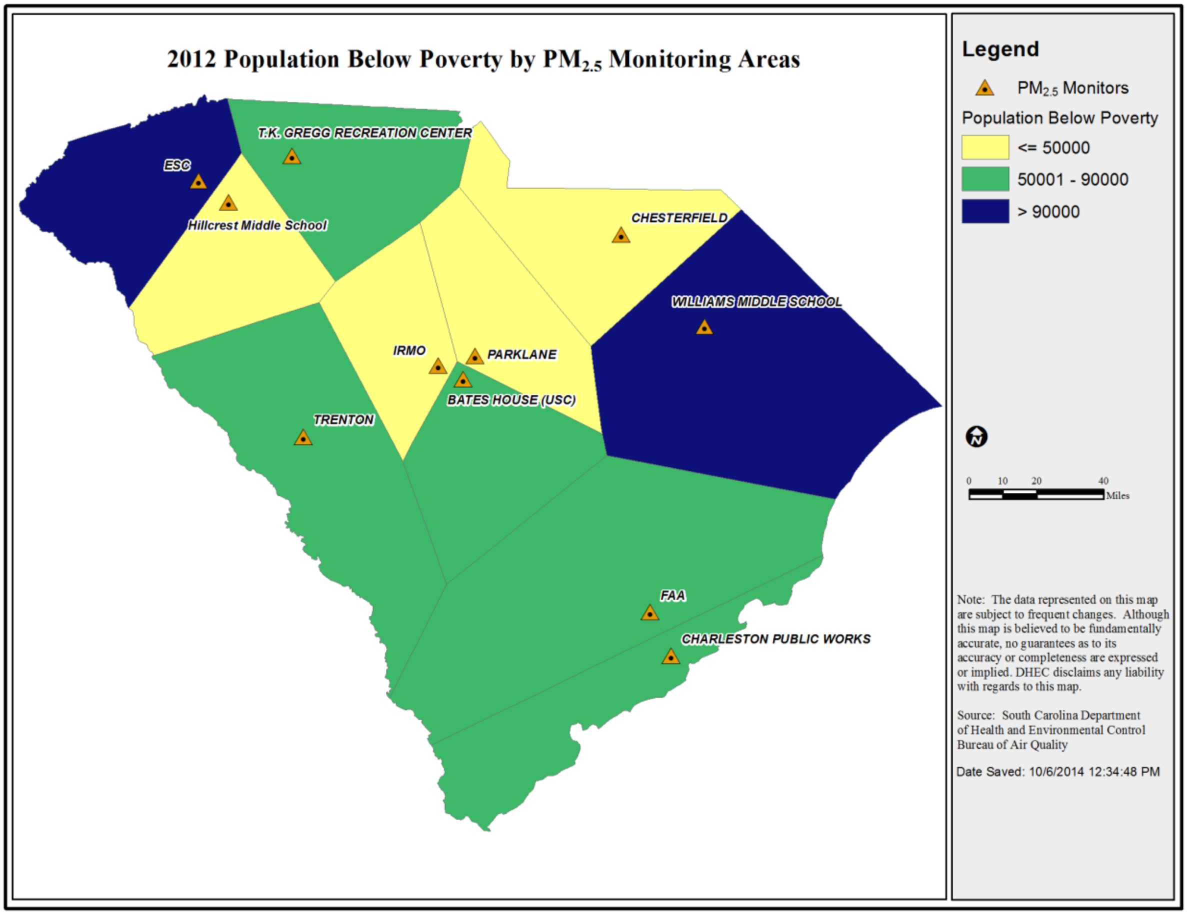
Population change




Percent Population Change Between 2009 and 2012
by PM2.5 Monitoring Areas
T.K. GREGG RECREATION CENTER
ESC
Hillcrest Middle School
CHESTERFIELD
WILLIAMS MIDDLE SCHOOL
IRMO
PARKLANE
BATES HOUSE (USC)
TRENTON
FAA
CHARLESTON PUBLIC WORKS
Legend
PM2.5 Monitors
Percent Population Change
3 - 4
4 - 6
> 6
0
10
20
40
Miles
Note: The data represented on this map are subject to frequent changes. Although this map is believed to be fundamentally accurate, no guarantees as to its accuracy or completeness are expressed or implied. DHEC disclaims any liability with regards to this map.
Source: South Carolina Department of Health and Environmental Control Bureau of Air Quality
Date Saved: 10/6/2014 12:27:02 PM

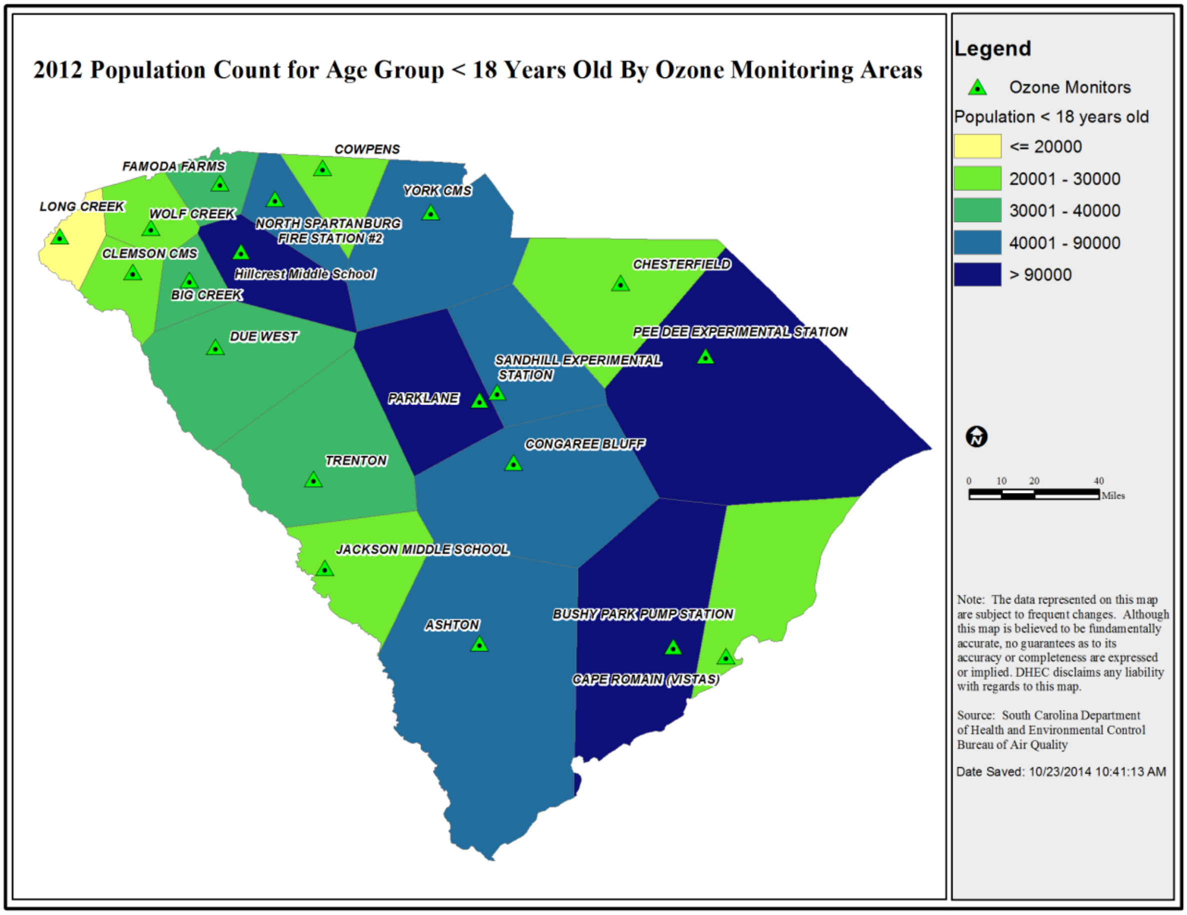
Poverty Rate

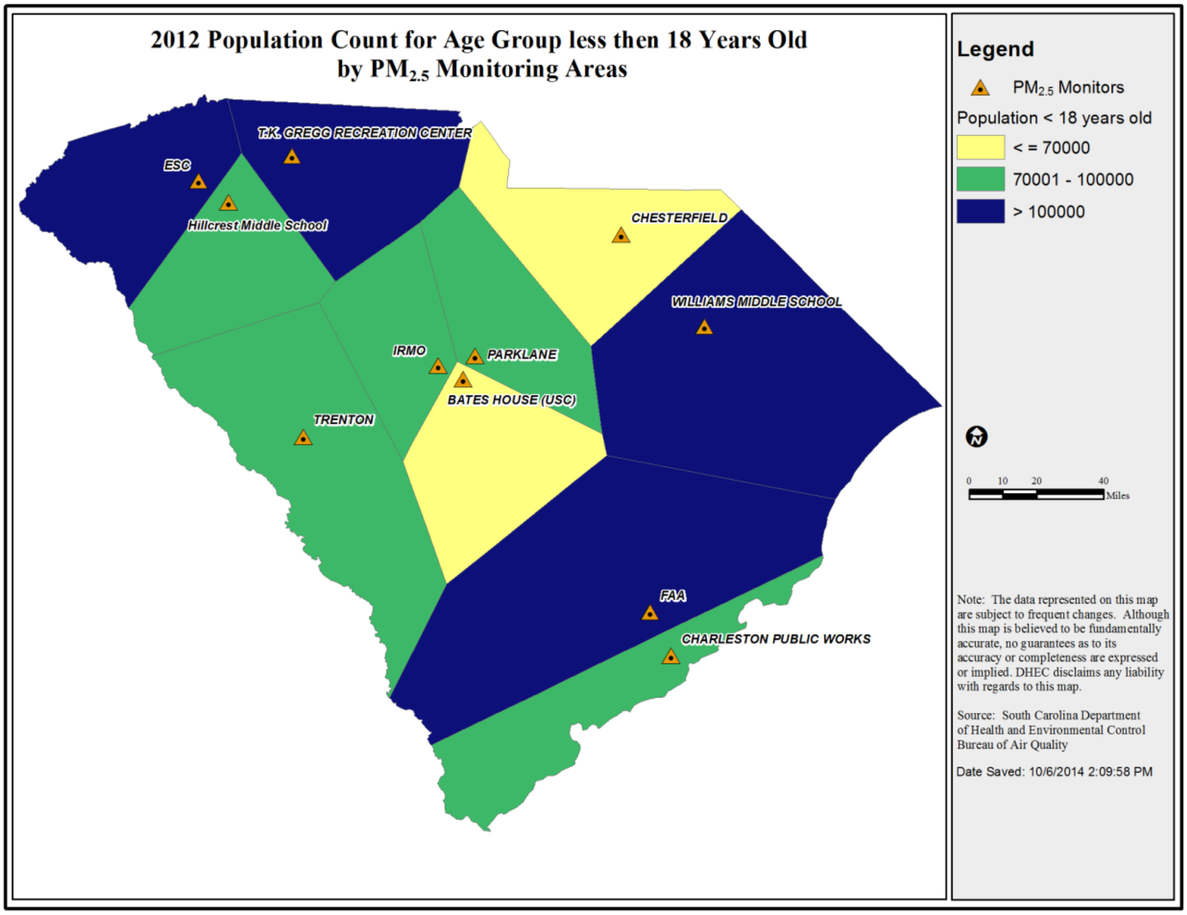




2012 Population Below Poverty by PM2.5 Monitoring Areas
T.K. GREGG RECREATION CENTER
ESC
Hillcrest Middle School
CHESTERFIELD
WILLIAMS MIDDLE SCHOOL
IRMO
PARKLANE
BATES HOUSE (USC)
TRENTON
FAA
CHARLESTON PUBLIC WORKS
Legend
PM2.5 Monitors
Population Below Poverty
<= 50000
50001 - 90000
> 90000
0 10 20 40
Miles
Note: The data represented on this map are subject to frequent changes. Although this map is believed to be fundamentally accurate, no guarantees as to its accuracy or completeness are expressed or implied. DHEC disclaims any liability with regards to this map.
Source: South Carolina Department of Health and Environmental Control Bureau of Air Quality
Date Saved: 10/6/2014 12:34:48 PM

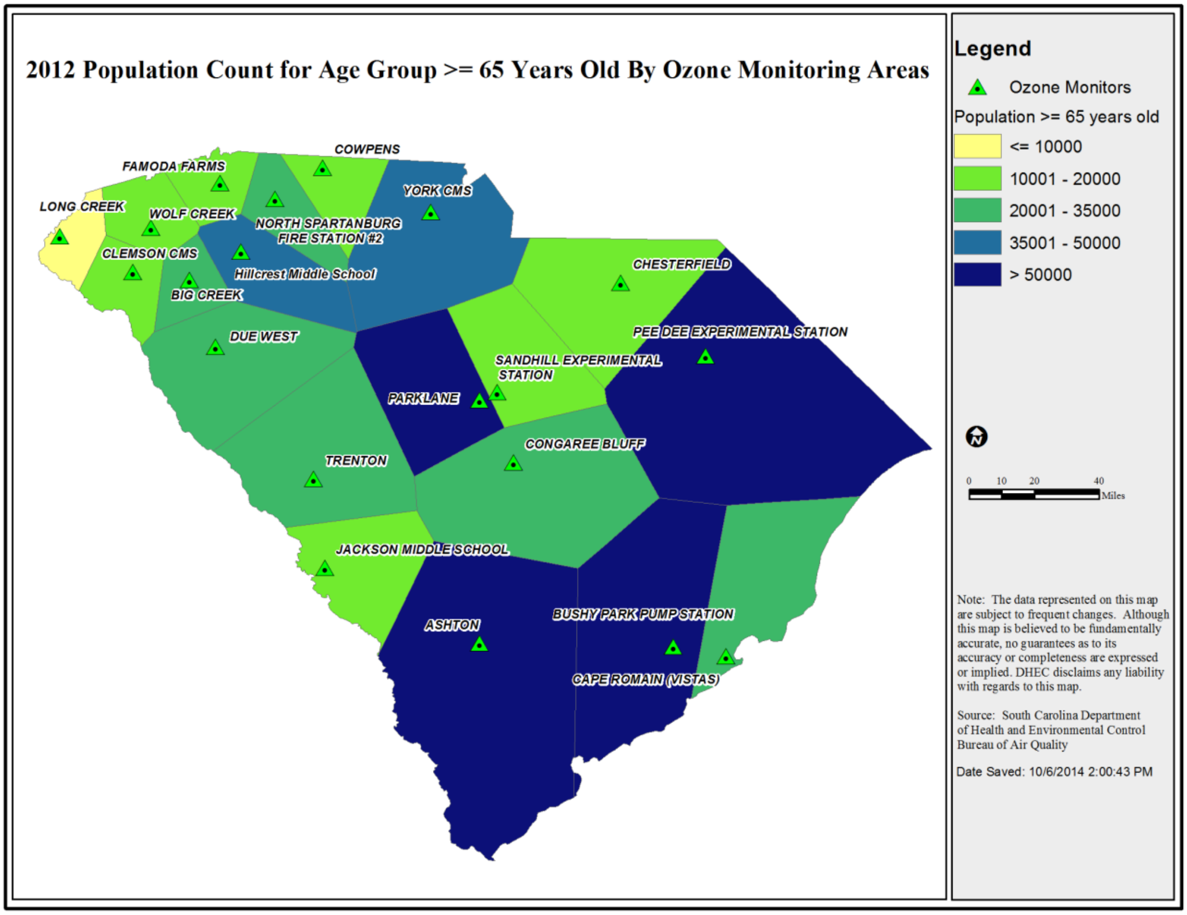
Population for Age 18 and Below

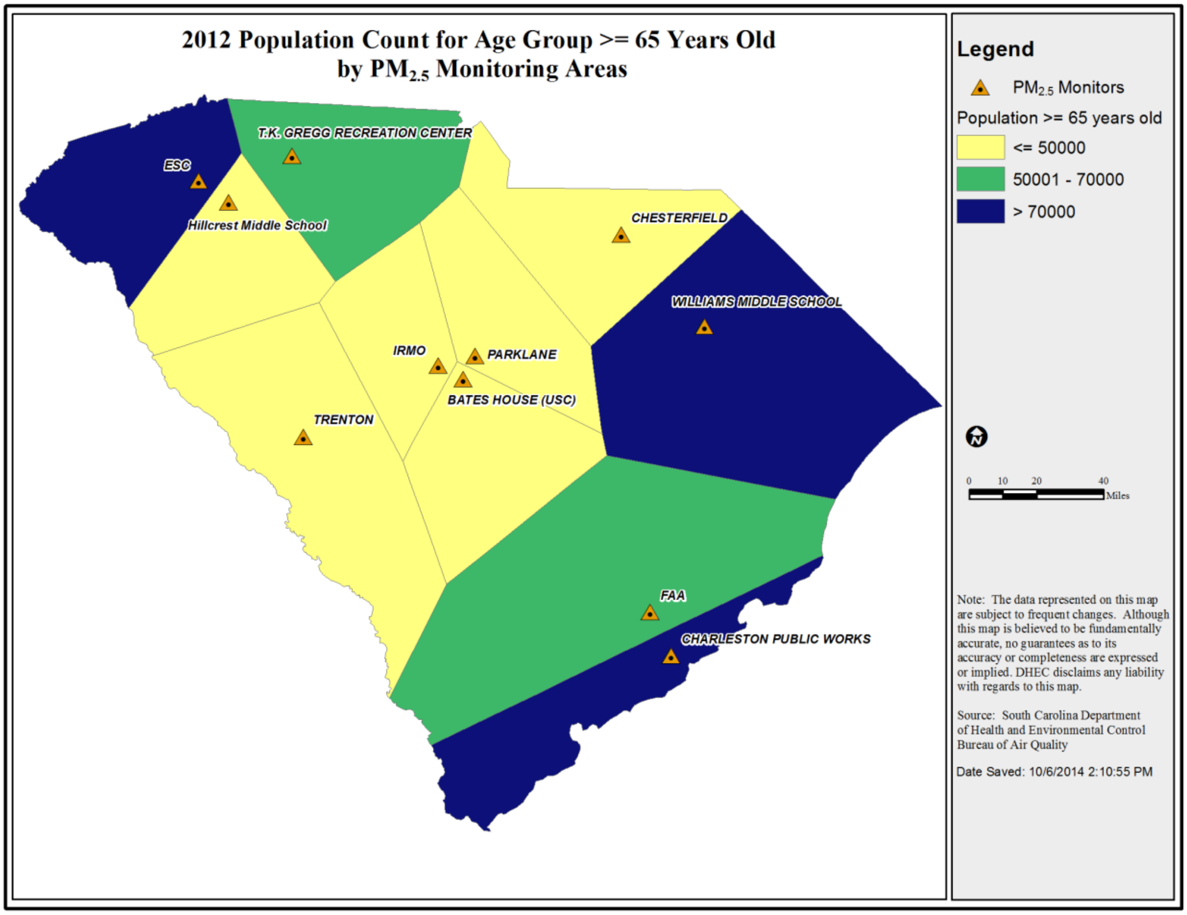




2012 Population Count for Age Group less then 18 Years Old
by $PM_{2.5}$ Monitoring Areas
T.K. GREGG RECREATION CENTER
ESC
Hillcrest Middle School
CHESTERFIELD
WILLIAMS MIDDLE SCHOOL
IRMO
PARKLANE
BATES HOUSE (USC)
TRENTON
FAA
CHARLESTON PUBLIC WORKS
Legend
$PM_{2.5}$ Monitors
Population < 18 years old
< = 70000
70001 - 100000
> 100000
0 10 20 40
Miles
Note: The data represented on this map are subject to frequent changes. Although this map is believed to be fundamentally accurate, no guarantees as to its accuracy or completeness are expressed or implied. DHEC disclaims any liability with regards to this map.
Source: South Carolina Department of Health and Environmental Control Bureau of Air Quality
Date Saved: 10/6/2014 2:09:58 PM

Population for Age 65 and Above




2012 Population Count for Age Group >= 65 Years Old
by $PM_{2.5}$ Monitoring Areas
T.K. GREGG RECREATION CENTER
ESC
Hillcrest Middle School
CHESTERFIELD
WILLIAMS MIDDLE SCHOOL
IRMO
PARKLANE
BATES HOUSE (USC)
TRENTON
FAA
CHARLESTON PUBLIC WORKS
Legend
$PM_{2.5}$ Monitors
Population >= 65 years old
<= 50000
50001 - 70000
> 70000
0 10 20 40
Miles
Note: The data represented on this map are subject to frequent changes. Although this map is believed to be fundamentally accurate, no guarantees as to its accuracy or completeness are expressed or implied. DHEC disclaims any liability with regards to this map.
Source: South Carolina Department of Health and Environmental Control Bureau of Air Quality
Date Saved: 10/6/2014 2:10:55 PM

Appendix H: Weighting scheme used in network assessment technical tools

Weighting technique showing the importance of each category	
Criteria	Weight
Area served	2%
Measured Concentrations	26%
Deviation from NAAQS	20%
Emissions	10%
Population:	
Population Change	2%
Population Living Below Poverty Level	2%
Population for Age 18 and Below	14%
Population for Age 65 and Above	14%
Time in Service	5%
Number of Parameters	5%